SCIENTIFIC AMERICAN

No. SUPPLEMENT 510

Scientific American Supplement, Vol. XX., No. 510. Scientific American, established 1845. | NEW YORK, OCTOBER 10, 1885. | Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

ENORMOUS PASSENGER TRAFFIC.

OVER 1,650 trains pass over the junction of the New York elevated railroads at Chatham Square every twenty-four hours. No railroad in the world does an equal train business on two tracks. There is a junction in London where 2,400 trains pass daily, but four tracks are provided for their accommodation. At certain hours of the day the New York elevated railroads are worked almost up to their full capacity. Improved terminal facilities will increase the means of handling traffic to a considerable extent, especially on the north end of the Third Avenue line. If the company were now compelled to adopt an absolute block system, which would keep the trains a certain distance apart, they could not handle the business now done on two tracks.

The only railroads in operation that compare with the New York elevated railroad system for crowded business are the London underground railways. The underground railways carry an enormous number of passengers, and the traffic has developed very rapidly. In 1879 a total of 91,420,178 persons were carried by the London underground railways, while in 1884 the number had increased to 114,447,514. During the corresponding five years the New York elevated railroads showed an increase from 46,045,181 to 96,702,620. While London still remains a good distance ahead in the grand totals, as it does in population, the ratio of increase was largely in favor of the American metropolis; in other words, while the Underground showed an increase of 23,027,336 in five years, the Elevated had expanded its figures by 50,667,430, at which rate it will not take New York long to catch up with London.

COMPRESSED AIR MOTOR.

IN the new motor for street car service, designed by Mr. Robert Hardie, an attempt has been made to remove the former objection to this system, by increasing the compression of the air, and so reducing the volume of the necessary reservoirs. To better distribute their weight, and economize space, six reservoirs are used, but are all in communication. They have a total capacity of 112 cubic feet, and have been tested up to 850 pounds pressure.

The initial pressure of the air is 600 pounds per square inch, but this is reduced by means of automatic valves to between 120 and 140 pounds before being used. At this pressure the air is heated in contact with water at a temperature varying from 240° to 280° Fah. The boiling point of water at 120 pounds pressure being raised to 340° Fah., no steam will be produced. The moisture absorbed by the air in its passage over the hot water is converted into steam, when the expansion of the air in the cylinder sufficiently reduces the pressure, and condensing, gives up its latent heat to the air, thus returning the heat and energy lost in expansion, and preventing the production of injurious cold. The indicator diagrams support this explanation, as they show a near approach to isothermal expansion.

Two of the objectionable features of the steam motor, the loud exhaust and the noise of brake release, have been eliminated; the one by an effective valve arrangement, and the other by a differential piston which silently releases the brakes. The motor weighs about six tons, but as the weight is distributed over three pairs of wheels, it is thought that the common street rail will be sufficiently heavy. It was designed for a run of ten miles, but the ordinary route of shorter distance would require considerably less weight of reservoir.

The utilization of power for the compression of air and its reconversion into energy involves a loss of 50 per cent.; the heating device, however, increases the efficiency of the motor, and there is a manifest economy in the centralization of power, as has been demonstrated in the cable and electric systems; but even admitting the duty to be less in air motors than in steam, the absence of noise and dirt would be more than compensation. And, moreover, any system with central motive power has a great advantage in being capable of a nice regulation between the supply of power and the immediate demand.

Mr. Hardie's motor has been running successfully on the line of the Steinway and Hunter's Point Railway Company, in Astoria, L. I., and is now awaiting adoption by that corporation.

THE manufacture of solid carbonic acid gas has been carried on for some time in Berlin. It comes in small cylinders, and if kept under pressure will last some time. A cylinder one and a half inches in diameter and two inches long will take five hours to melt away into gas.

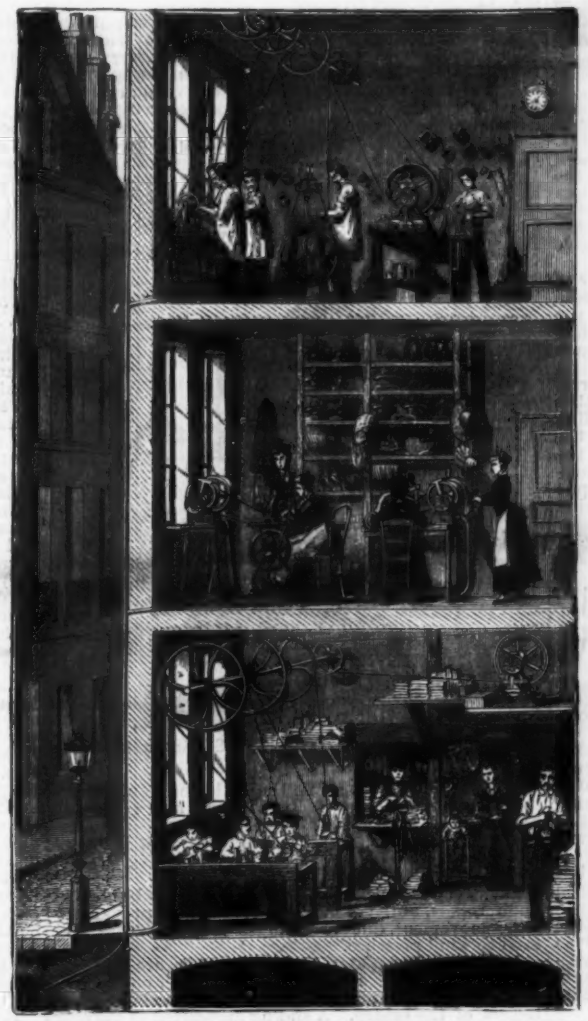


FIG. 3.—SECTION OF A HOUSE, SHOWING THE DISTRIBUTION OF RAREFIED AIR TO SMALL SHOPS.

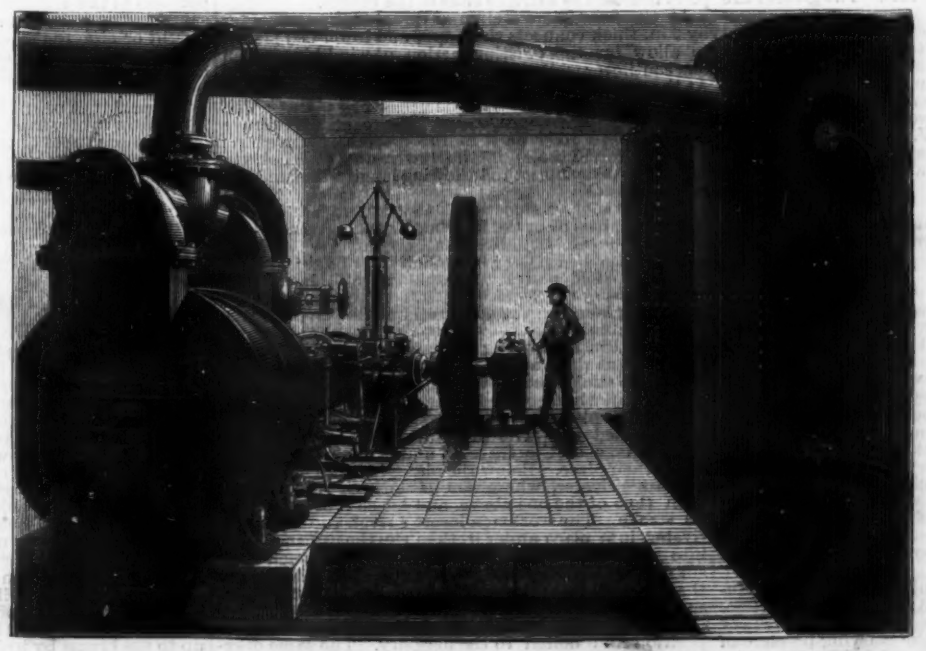


FIG. 1.—DISTRIBUTION OF RAREFIED AIR.—INTERIOR OF CENTRAL STATION.

DISTRIBUTION OF POWER TO HOUSES BY RAREFIED AIR.

THE problem of the distribution of power has for a few years past been solved in such a way as to satisfy the exigencies of the large industries. Engineers have now but the trouble of choosing. Mr. Hirn's telodynamic cables are applied at Bellegarde and in a large number of spinning mills in Alsace and Normandy; water under pressure is employed at the London docks, in the ports of Anvers and Marseilles, and at the Paris station of the Railway of the North; compressed air, which was employed in piercing the great Mont Cenis and St. Gothard tunnels, is used at Nantes for operating tramways, and at Birmingham it serves for more varied purposes; steam, which has been adopted in certain cities of the United States, principally at New York, for heating, is tending to become likewise an agent for transmitting power to a distance, and Mr. Chretien has recently set forth the advantages thereof in a memoir. In addition we may take into account the services that electricity is rendering in large establishments, such as factories, railway stations, ports, etc., where various processes are in use that permit of cheaply distributing within a circumscribed area the power yielded by a fall of water or a steam engine.

The question presents itself under an entirely different aspect when, in an industrial center, it is a question of putting motive power at the disposal of, not a few consumers, but a large number of small customers, whose intermittent and varied work requires a stress that rarely exceeds the power of one horse. Such is the case at Paris, for example, where there are thousands of small workshops, the majority of which, up to the present, are reduced to the necessity of using the pedal or winch.

The systems just mentioned would not answer, either because of the impossibility of installing some of them (such as telodynamic cables), or of the too high price of others (such as water under pressure, etc.), not to speak of hygienic considerations, which are never out of place. There remain, it is true, gas and water, from which excellent advantages may be obtained. Gas motors of one-half and one H. P. are already in extensive use, and would be more so were not the high cost of the engine, of setting it up, and of the gas, a serious obstacle to it.

The small hydraulic motors adopted in Switzerland, and in localities where one has at his disposal a great pressure in the water mains, would not be accepted at Paris, where water is much too dear. There was occasion, then, for this city to look about for some mode of distributing power to houses that should recommend itself in the very first place by its relative cheapness. The use of rarefied air in the special manner that we are going to describe permits of satisfying such a condition.

The idea of forming a vacuum in a receptacle or system of piping, and of using it for producing power, dates back, it seems, to Papin, who, nearly two centuries ago, recommended it in the Actes des Savants de Leipzig. Papin's idea has been carried out by his successors in the following manner: At the central station a steam engine keeps up a mean vacuum of 70 per cent. in a system of piping which is connected by vertical pipes and branches with the motors in the small shops of subscribers.

The central station, of which we give a view in Fig. 1, is located at No. 41 Deanbourg Street. It contains at present a steam generator of 168 square yards heating surfaces, located in the basement, and a 75 H. P. horizontal Corliss engine provided with the most recent improvements. The rod of the steam piston is connected directly by keys with the rod of the air cylinder, which is placed in a line with the steam one. In the air cylinder, the elevation of temperature that accompanies compression is prevented by injected water, as in ordinary compressors. A special regulator keeps up a concordance, within sufficiently narrow limits, between the variations of the engine's velocity and the degree of vacuum in the conduits, which enter a reservoir in which the wind cylinder operates.

The piping, starting from the station, consists of cast iron mains 10 feet in length, whose diameter continues to decrease in measure as they proceed farther from the works. The joints are covered

with a ring, and tightness is secured by means of melted lead. The mains are placed in the sewers, as shown in Fig. 3, and are tapped at certain intervals for connection with the vertical pipes. These latter are of lead, and of variable diameter according to the number of motors to be supplied. They are provided with a cock that permits of opening or closing communication with the main. The service pipes are connected with the vertical pipes, and are provided with a special cock. These details are imitations of what we find in gas and water distribution, and so we need not dwell upon them. The service pipes connect with motors of two types. The first of these, the expansion joint motor, is constructed in three sizes, and is shown in Fig. 2. It is a double acting and expansion engine. Distribution is obtained by means of a system of levers actuated by a button that moves along a sleeve, as in the Pengeot sewing machine. A centrifugal governor, actuated by the shaft, is arranged upon the suction pipe and opens it more or less, so that the motor can be regulated to a certain number of revolutions. The external air is admitted at the atmospheric pressure during three-eighths of the pistons stroke, and afterward acts by expansion.

The other motor, a rotary one adapted for small powers, is likewise an expansion engine. The admission of air occurs through a clack valve in the side of the cylinder jacket, and regulation is effected by opening the suction orifices more or less widely.

A revolution counter shows the work done by each motor, and its indications serve as a guide for making out the monthly bills.—*La Nature.*

THE FORTH BRIDGE.

By THOMAS C. CLARKE, Member American Society of Civil Engineers.

THROUGH the kindness of Messrs. John Fowler and Benj. Baker, engineers of the great bridge across the Firth of Forth at Queensferry, about ten miles from Edinburgh, I enjoyed exceptional advantages for seeing the works now in progress of construction; and for the benefit of those who have not yet seen them I will give as clear a description as I can of what I saw.

The first thing which strikes one is the grandeur of the scenery, and the immense scale of everything connected with the crossing. The Forth is an arm of the North Sea, generally about three miles wide at this point, and with fine bold hills rising abruptly from each shore.

At the point selected for crossing—the old Queensferry, so familiar to the readers of Scott's novels—the Forth is narrowed to about 1½ miles; and Nature, as a standing challenge to engineers, has placed a rocky island in the center to build a pier upon. On this island stands the ruined castle of Inchgarvie, which has been temporarily converted into a barracks for workmen, and upon the tower of which is a group of large and small wind gauges.

Perhaps the best way of giving an idea of the size of this bridge is to compare it with the New York and Brooklyn bridge.

The two main spans will each be 1,710 ft., or 114½ ft. longer than the main span of the Brooklyn bridge. The clear headway of the spans will be 150 ft. above H. W., or 15 ft. higher than the Brooklyn bridge. The three main towers will be 375 ft. high, or 98½ ft. higher than those of the Brooklyn bridge.

The whole length of this bridge will be 8,084 ft., while that of the Brooklyn bridge is 5,989 ft. To complete the comparison, the cost of the Brooklyn, exclusive of land and interest, was $11,000,000, and it took about thirteen years to build it. The Forth bridge is contracted for at the sum of $8,000,000, and it is estimated will take from five to six years to complete it. Judging from the progress that has been made during the two years that have been spent, I believe that this time will not be exceeded.

I make these comparisons in no invidious spirit, but merely to show the progress of engineering science in the last fifteen years.

The works naturally divide themselves into the viaducts at each end, the piers and foundations, the superstructure of the main spans, now under construction in the workshops on the south or Edinburgh shore. There are about ½ mile of viaducts and a mile of main spans.

The viaducts consist of 15 spans of 168 ft. and 5 of 25 ft. of riveted lattice girder deck bridges 27 ft. wide between the wind screen parapets by about 30 ft. deep, and with the top 150 ft. above tide. The girders are continuous over two spans.

The plan of construction is to put down piers of concrete faced with Aberdeen granite, by means of coffer dams, to the rock or to the bowlder clay, which is covered with a slight depth of mud and silt. The tops of these piers are about 20 ft. above H. W. The spans are completed on stagings between the piers, at the general level of 20 ft. above H. W.

They will hereafter be raised simultaneously by hydraulic power at each pier, and the masonry built up under them as fast as they rise. Mr. Wm. Arrol, the contractor, is a specialist in the adaptation and use of hydraulic power, and employs it wherever he can dispense with manual labor, preferring it to the direct application of steam power, such as we generally use on public works in this country.

It will be seen that this mode of erecting the viaduct spans dispenses with high stagings, resting upon what would be expensive foundations. It is not a rapid process, but as they have plenty of time, this is no objection.

After looking at the viaduct, we walked out upon a pile pier to the place where they are sinking the last of the foundations on the Edinburgh side. The foundations of all the main piers are caissons 70 ft. in diameter with double skins, sunk with the aid of compressed air. The space between the skins is 7 ft., and is filled with concrete to give weight for sinking; and lastly, the inner space is filled with concrete to L. W. mark. Upon this the circular piers, built of local whin and Arbroath stone faced with Aberdeen granite, are carried up to about 18 ft. above H. W., where the diameter is 49 ft.

These caissons have been fully illustrated in *Engineering;* see also SCIENTIFIC AMERICAN, April 4, 1885.

The top of the air chamber is formed of very heavy girders, proportioned to resist the varying pressure of a difference of 20 ft. between H. and L. W. The principal novelty in these caissons, apart from their great size, is the mode of working the air locks by hydraulic power, which has also been fully illustrated in *Engineering,* SCI. AM. SUPP., Nos. 354, 457.

This system works very smoothly and rapidly, and saves much time in passing materials through the air locks; about 100 cubic yards are lifted in 24 hours. I should say that this device had saved at least one year's time.

Another novelty is the use of hydraulic spades, or chisels, to cut away the bowlder clay. They are 8 in. wide by 2 ft. long, and cut a face, or succession of faces, breaking up the clay so that it is easily handled. They also undermine bowlders.

As I did not go down into the compressed air, I did not see these chisels in operation, but there is no doubt that they are an excellent tool. Under similar caissons the rock, which slopes some 18 ft. in the diameter of the pier, is leveled to true horizontal beds, which necessitates cutting away large masses of rock. The concrete mixer will deliver 140 cubic yards in 24 hours. There are now but two more caissons to be sunk. One was towed to position the day after I was there. I was told that three tugs towed it a mile and placed it in position in less than two hours.

The caissons and all the rest of the steel work, except the bed plates, are painted with red lead and oil.

An accident (the only serious one they have had) happened to one of the caissons. The tide overflowed it and upset it, and on pumping out the pressure of the water burst a hole in one side. They have put two circular steel rings in the inside, and are covering the hole outside with sheet piling 13 in. thick, very carefully jointed together. They will then pump it out and convert it into its normal state of a great tub floating on the water, whose bottom is the top of the caisson.

They expect to get the caissons all sunk by the end of the present year.

As we passed Inchgarvie rock we saw, on the top of the old castle, the great wind gauge 20 ft. by 15 ft., with a small one like a little door, about 2 sq. ft. area, near the center and two others flanking it on either side. Mr. Baker told me that when the large gauge

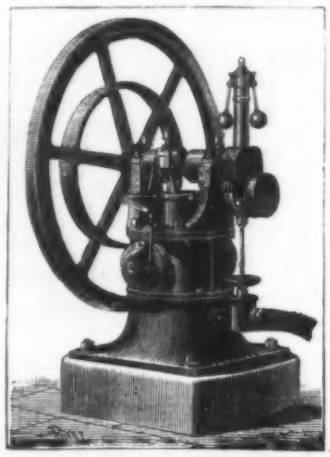


FIG. 2.—SMALL MOTOR FOR SUBSCRIBERS.

registered 12 lb. per sq. ft. the little one would sometimes go up as high as 25 lb., showing how very local high wind pressures are, like jets of water.

On the north, or Fifeshire, shore we saw the very interesting process of constructing and laying the bed plates.

The weight of the bridge was too great to be carried upon rollers, and yet it was necessary to provide for some movement, due to changes of temperature, and even to wind pressure.

A pair of bed plates, 17½ ft. by 37 ft., are made by riveting steel plates together. The lower one is fixed to the masonry and the upper one to the base of the towers of the bridge. A sliding movement of varying amount is provided for in all but the fixed points, in the direction of the longitudinal axis of the bridge. No cross movement is provided for, except at the main piers nearest the extreme ends of the bridge.

At the fixed piers a circular dowel 12 ft. in diameter by 2 in. thick connects the upper and lower bed plates, to allow for the twisting action of wind blowing on one cantilever while the balancing cantilever is in calm. At the others, the holding-down bolts of the lower bed plate play in oval holes in the upper bed plates. The piers under the shore ends of the cantilevers have holding-down rods built in the masonry and passing through round holes in the lower, and oval holes in the upper bed plates, thus allowing longitudinal motion only.

The mode of construction is as follows. The granite coping of the piers in first bush-hammered to a true surface.

The lower bed plate is then built up of 5 thicknesses of 1¼ in. steel plates, laid crosswise and lengthwise upon each other, breaking joint. These plates have all been planed on the edges, and made perfectly true by straightening.

A tool like a traveling crane, having motion in two directions at right angles to each other, and traversing the whole size of bed plate, contains a number of drills, which drill the required rivet holes and countersink them. The plates are then temporarily bolted together and blocked up. The drills are then removed from the carriage of the traveler, and a hydraulic riveter put in their place. Below the plates is another movable hydraulic riveter, whose ram has an area ½ in. greater than that of the one above, and hence is able to resist its stroke. The workmen insert a rivet, run the lower riveter into place under it, then run the upper riveter into place above it. The two rams press each head simultaneously, and the work is done. It will be seen that this mode of hydraulic riveting can command a surface of any size.

After the plates are riveted they are lowered into position and bolted to the masonry. The same operation is then performed with the upper bed plate.

The two surfaces of contact are ground with emery wheels, and the whole is covered with crude petroleum, in which they will be submerged as in a bath, to prevent rust and act as a lubricant. Not only the round but also the oval holes are drilled by a tool which I will describe hereafter.

After viewing these works sufficiently we adjourned to the offices for lunch, which was served with great hospitality to the directors of the bridge company and their guests.

Quite a large town has been built here to lodge the 2,500 persons who are engaged on these works. This is built on the property of Lord Rosebury, who has stipulated that it shall all be removed when the works are done.

We then visited the workshops, which stand immediately on the bank of the river, on a level plateau about 170 feet above tide.

Everybody knows that the practice in American bridge shops is to make all the different parts, such as upper chord pieces, eyebars, posts, floorbeams, etc., according to figured drawings. These are sent to the site of the bridge, and come together on the scaffolds for the first time, except in very intricate work, where a piece of a floor or one girder is put together lying on its side.

In British shops the practice is to erect and fasten together by bolts at least one span in the yard. This is erected complete, and then taken apart and shipped to the site and re-erected. At the Forth bridge, as special tools had to be made for everything, there seemed to be no place so fit for the shops as directly at the site of the bridge.

To this place all the plates and rolled sections are sent from the steel mills at Glasgow and Landore. All parts of the structure then go through the following processes:

1st. They are sheared, planed, or sawed to the exact dimensions required.

2d. They are then fitted together in the exact position they will occupy relatively to each other in the bridge.

3d. The rivet holes are then drilled by power drills.

4th. They are taken apart.

5th. They are again placed in final position on the scaffolds.

6th. They are riveted by hydraulic riveters.

The plates which form the tubes (those I saw were 6 ft. × 16 ft. × 1¼ in. thick) are heated in a gas furnace, stamped to the required radius of curvature in a huge hydraulic press of 2,000 tons capacity, and are allowed to anneal by slowly cooling, after which they get a straightening squeeze.

They are then planed to exact dimensions by a tool which planes side and end at once, thus insuring exact rectangularity.

Angles and shapes are sheared, but I also saw much use made of the cold saw, familiar in American iron mills.

The tube plates are bolted together over circular mandrels and drilled by multiple power drills. (This tool has been illustrated in *Engineering;* also see engravings, SCIENTIFIC AMERICAN SUPPLEMENT, No. 478.) Where large flat surfaces require drilling, they are drilled by the method described for the bed plates. Where connections have to be made, the parts are set up in the yard in exact position and drilled. The question is frequently asked, "How are the connections made?" They are made by drilling and riveting, just as the members are made, except that they change their shapes from round to oval or rectangular, and are re-enforced by inner gussets, plates, angles, and diaphragms sufficient to maintain the same bearing or shearing pressure on the rivets as in the main members. I need hardly say that this is a work requiring the greatest judgment and skill, and a plank model full sized is made of every connection, and is discussed by the engineers and contractors before adoption.

The tubes taper from 12 ft. to 5 ft. diameter, and the maximum area is 830 square inches.

The tension members are four-sided lattice girders from 12 to 5 ft. deep, having the required area in the corners in the shape of tees, angles, and plates. The maximum area is 506 square inches.

Sometimes they have two sides made of plates. They are fitted together and run through a tool which drills 5 holes at once on three sides, or 15 in all, besides having radial arms for irregularly spaced holes.

The oval holes are drilled by a tool made on the principle of the last-cutting or gunstock-cutting tools which we have.

From what has been said it will be evident that the problem of the erection of this great bridge is much simplified on account of there being no parts of great weight or size to lift, and because, all the fitting and drilling having been done in the shops, there will be none to do in the stagings, and every part must come into exact position.

The problems of erection are, then, as follows:

1st. How to construct scaffolding sufficient to support one or more tubes or tension members while being put together.

2d. How to drive the rivets.

3d. How to arrange so that men can work night and day.

4th. How to get the men to and from their work.

The first process will be to erect the main tower on the Fife side, which is 375 feet high and 150 feet by 120 feet wide at the base. A scaffold, consisting of a pair of lattice girders properly united together, will be raised by hydraulic power up along the main columns themselves as they are put together, by means of a system of slots and pin holes in the columns, and movable pins. From this scaffold will also be constructed the diagonal and horizontal members, all of which will be put together on the scaffolds in small pieces and then riveted. Similar scaffolds at right angles will be used to construct the cross bracing uniting the up and down stream sides of the tower. The whole of the lattice girder scaffolding will consist of portions of steel work forming part of the permanent structure, and held together temporarily by bolts. The tower having been completed, a pair of lattice girders, C D, properly united will be suspended on each side of the tower by temporary suspension cables.

Upon these the main struts will be built. Another set of lattice girders will be used to carry up the bracing members, in the same manner as the tower was built. That is to say, these lattice girders will be raised up to the braces by hydraulic power, and held by pins as before.

After this is done, the railway tracks and cross bracing will be put in, and one panel complete on each side of the tower will be placed. The scaffoldings will then be moved forward, and the succeeding panels will be built in the same way.

It is proposed to carry out the 350 foot central spans on pontoons after being completed on the shore, and raise them into position by hydraulic power.

2. The plates, tees, angles, and other parts of the tubes and ties being assembled on the scaffolds, nothing remains but to rivet them together. It is evident that by substituting the usual hydraulic riveters for drills, much of the work can be done. But for riveting the plates of the tubes together, and for many other places, the usual single riveter could not be applied; and here comes in the use of the double riveter, which I have described as being used in riveting together the bed plates. All that is required is a point of support for each of the riveters, and the rams come out simultaneously on each head of the rivet, one having more power than the other. This tool seems to solve an otherwise difficult problem.

3. In order to enable the men to go on night and day irrespective of darkness, wind, and weather, the scaffolds will have tops, bottoms, and sides. They will be in fact comfortable workshops hung up high in air above the waters of the Forth. A complete system of lifts or elevators will take the shifts of workmen up to and down from their work, so that neither time nor bodily effort will be wasted.

Work can thus be carried on at six main points and many subordinate ones at once, night and day, without ceasing until the whole is done.

In round numbers, there will be about 42,000 tons of steel in the superstructure of this bridge, of which 15,000 tons is delivered.

About 60 miles of plates from 1¼ in. to ⅜ in. thick have to be bent for the tubular compression members.

I have only now to answer the question, How does this work strike an American engineer familiar with bridge construction in the United States?

The first thing that impresses itself upon the observer is the admirable adaptation of the general design of this bridge to the natural and physical conditions of the crossing.

In no other manner could the Forth have been crossed with so little outlay of material and labor.

The enormous spans of 1,710 ft. having been decided upon, it is evident that the most important question to be solved is, how to resist the wind pressures.

The arched cantilever form, which carries the strains by the shortest path to the supporting piers; and the batter, or increase of width of all parts toward the base, gives a most happy solution of this problem.

As in all works of genius, the simplicity of the means adopted for overcoming the difficulties is very marked.

Passing from the general design to the details of construction, we are pleased to see two distinctively American features of construction—the concentration of material along the lines of strains, instead of the diffusive system generally employed in English and European bridges; and the adoption of hollow circular columns for compression members.

To Messrs. John Fowler and Benjamin Baker is due the credit, not only of having made this admirable design as above described, and also of having investigated for the first time by scientific methods the problems of wind pressure, but they have also designed and are responsible for the minutest details of construction.

I may truly say that not a rivet hole is placed without passing under their personal notice and approval.

In designing the labor-saving machinery for executing their works the engineers have found a most able assistant in William Arrol, of the firm of Tancred, Arrol & Co., contractors.

I wish that all American bridge engineers and constructors could see their Forth shops with their labor-saving appliances.

While they would say that generally the United States is in advance of all other nations in the application of labor saving tools and processes, they would have to make an exception in favor of the Forth shops.

When we consider the originality of the design, the gigantic dimensions of all the parts, and the novelty of the methods of execution, all of which had to be specially invented, and then see how smoothly and rapidly the work of construction is being pushed on, we must say that these gentlemen have taken a step in bridge construction which marks a new era, and one far in advance of anything that has previously been done.

September 17, 1885.

THE CAR COUPLER TRIALS AT BUFFALO, N. Y.

THE Executive Committee of the Master Car-Builders' Association met at Buffalo, N. Y., on Tuesday, Sept. 15, and occupied itself during the remainder of the week in carrying out a systematic series of trials of automatic and safety car couplers. The following extract from a circular issued by the Committee in August last expresses the purpose of this meeting:

"The Executive Committee of the Master Car-Builders' Association, acting in accordance with the general instructions given by the Association at the last convention, will make a public trial of automatic freight-car couplers at Buffalo, N. Y., on Tuesday, Sept. 15, 1885.

"The Executive Committee will be guided by the results of their trial in recommending several forms of coupers to the railroad companies for further test in actual service. They will watch the behavior of those selected couplers until one month prior to the next convention of the Association, when they will prepare a report, and may recommend for universal adoption one or more different forms of automatic freight-car couplers.

"All parties desirous of presenting freight-car couplers to the consideration of the Master Car-Builders' Association are invited to participate in this trial.

"The Committee will not consider or investigate the merits of couplers represented only by models, drawings, or other descriptions. An imperative condition of the trial will be that couplers submitted to the Committee must be applied to two cars, so that they can be tested at the time and place named.

"The Executive Committee is not prepared to assist inventors or owners of patents on car couplers in procuring cars to be equipped and delivered at Buffalo ready for trial. Negotiations of this character must be conducted directly between the owners of the couplers and the railroad companies. It will also be necessary for parties furnishing cars for this trial to arrange direct with the railroad companies for their return."

A supplementary circular gave the requirements in regard to the estimates to be furnished by inventors, as follows:

"In replying to the question of cost of draw-bar the statement should cover the following items in detail:

"1. Cost of applying to new car, including all attachments to the main draw-timbers, such as draw-sills, bolts, springs, followers, etc.

"In making a comparison between the cost of applying the new draw-bar and common draw-bar, all parts which are common should be stated, showing the difference of applying to new car.

"2. Cost of changing old car to take the patent draw-bar, giving full details, cost of labor of removing old draw timbers and fixtures, and cost of replacing new draw-bar, giving labor and materials. The test will take place to-morrow afternoon at 1 o'clock, at Hamburg Street crossing, near dock track of Erie Railroad."

Forty-six couplers were entered for competition, but as four of these—the Ames automatic (Canadian), the Benedict, the Skinner, and the Westbrook—failed to put in an appearance, only forty-two were actually tested. These were as follows:

CLASS I.—COUPLING IN A VERTICAL PLANE.

Boston Automatic, Boston.
Cowell, Cleveland, Ohio.
Dowling, Columbus, Ohio.
Hitchcock, East Woolson, N. Y.
Hien, Lime Rock, Conn.
Hills, C. H. Blodgett, Burlington, Vt.
Janney, Pittsburg, Pa.
Joo, Roanoke, Va.
Le Roux & Van Aarle, Toledo, Ohio.
Muller, Atlanta, Ga.
Simpson, (Wilson Walker), Pittsburg, Pa.
Thurmond, Forsyth, Ga.
Titus & Bossinger, Huntingdon, W. Va.
Williams, Brattleboro, Vt.

CLASS II.—LOOSE LINK AND HOOK.

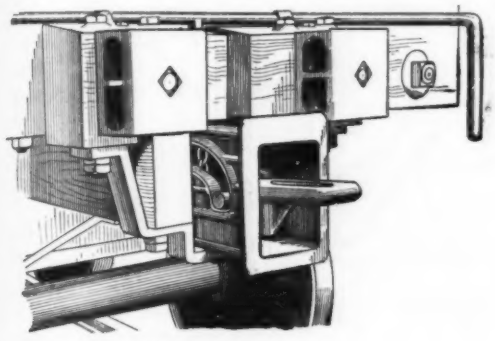
Archer, Saratoga, N. Y.
Hilliard, Middleboro, Mass.
Keily, Toronto, Canada.
Marks, Flint, Mich.
Meadows & Mead, McMinnville, Tenn.
Fitzgerald & Van Dorn, Lincoln, Neb.

CLASS III.—FIXED LINK AND NO PIN.

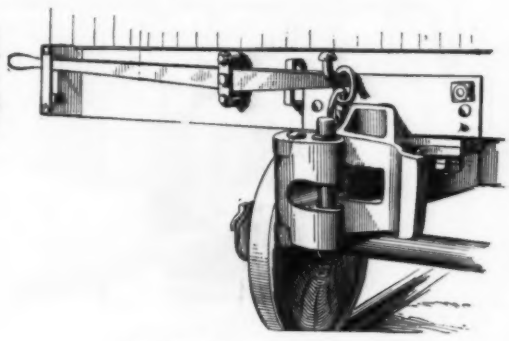
Ames, Philadelphia, Pa.
Stanford.
Smillie, 34 Maiden Lane, New York.

CLASS IV.—FIXED PIN AND LOOSE LINK.

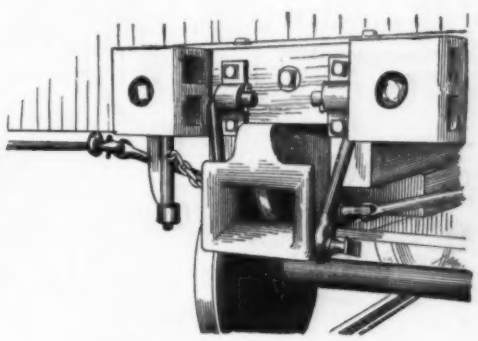
Brown.
Curtis & Wood, 140 So. Fourth Street, Philadelphia, Pa.
Eureka, Grand Rapids, Mich.
Gifford, Cincinnati.
Lancaster, Box 143, Cleveland, Ohio.
McKeen, Easton, Pa.
Murphy, Port Jervis, N. Y.
Perry, Chicago.
Union, Boston, Mass.
United States, Boston, Mass.
Whitman, Lyons, N. Y.



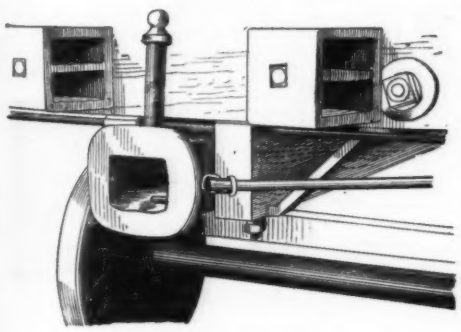
AMES—ADOPTED.



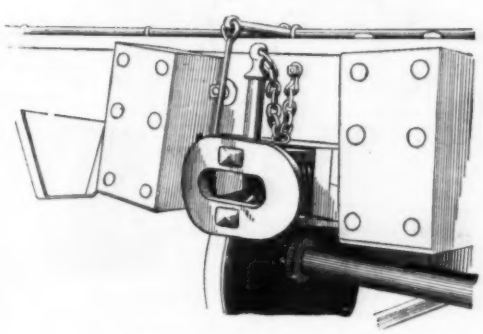
JANNEY—ADOPTED.



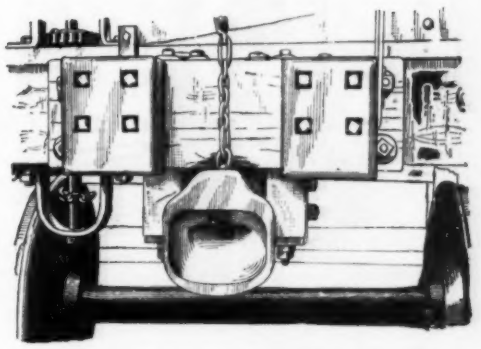
MARKS—ADOPTED



PERRY—ADOPTED.



McKEEN—ADOPTED.



ARCHER—ADOPTED.

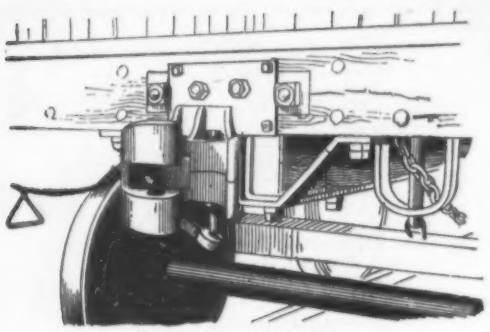
THE AUTOMATIC CAR COUPLERS TESTED AT BUFFALO, SEPT. 15–17, 1885, BY THE EXECUTIVE COMMITTEE OF THE MASTER CAR BUILDERS' ASSOCIATION

UNCLASSIFIED.

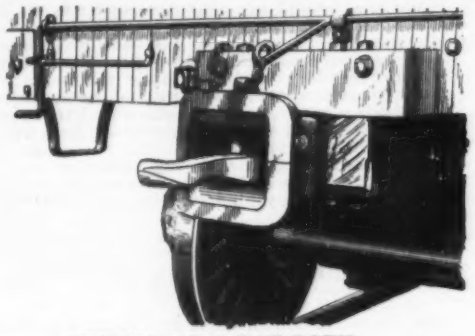
Barnes, Rochester, N. Y.
Bird, Pratt & Co., Buffalo, N. Y.
Curry, Ottawa, Canada.
Emmett, Logansport, Ind.
McCree, Lansing, Mich.
Morgan, Ann Arbor, Mich.
Payne, Packerton, Pa.
Russell Eccentric.

The results of these trials were carefully reported by representatives of the *Railroad Gazette*, to which we are indebted for our details and the excellent perspective views of the different couplers which we present. These have been prepared from a uniform set of photographs taken at the time of the trial. A uniform scale was secured by taking each photograph from the same distance, 72 inches from the pin or its equivalent. They were also taken with the same camera and with precisely similar dry plates, so that the scale is in all cases as nearly equal as is possible with a photograph. The varied conditions of light and position, under which the photographs were taken, required exposures varying from fifteen seconds to four minutes. Mr. I. Dressel of Buffalo was the photographer.

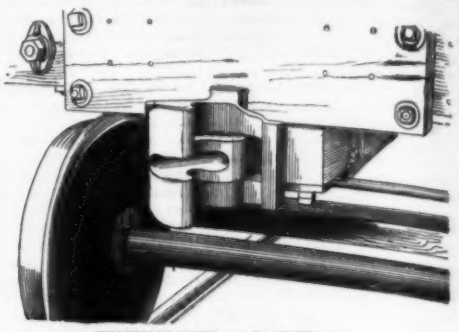
The movement of the cars was under the direction of Mr. Wilder, and the record of the results of the tests were kept by two assistants. The other members of the Committee, who were all representative railroad men, had less defined duties, but were by no means simply spectators. The gentlemen of the Committee



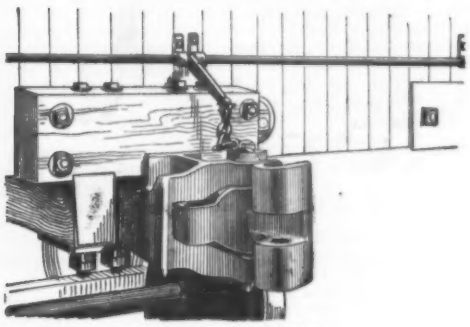
DOWLING—ADOPTED.



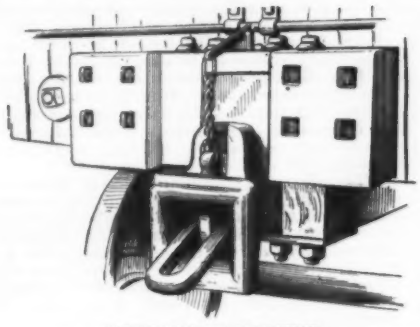
FITZGERALD & VAN DORN.



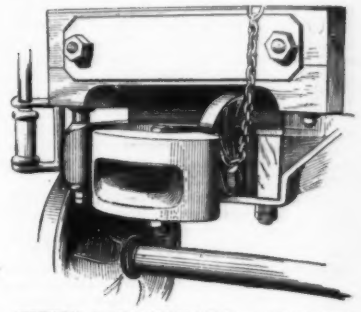
THURMOND—ADOPTED.



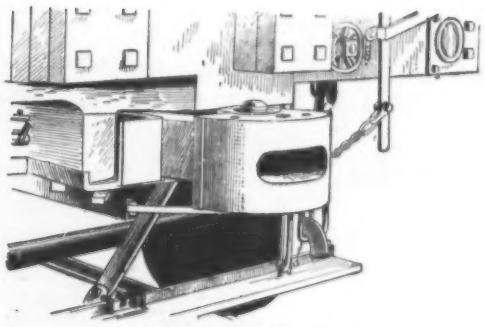
HIEN—ADOPTED.



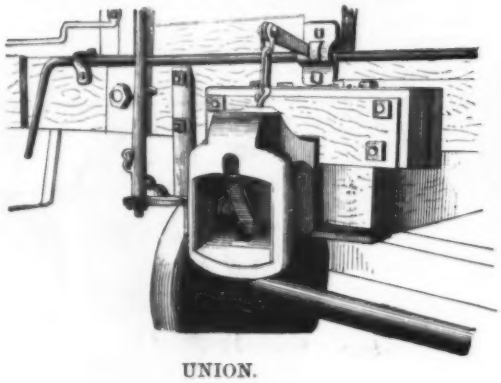
GIFFORD—ADOPTED.



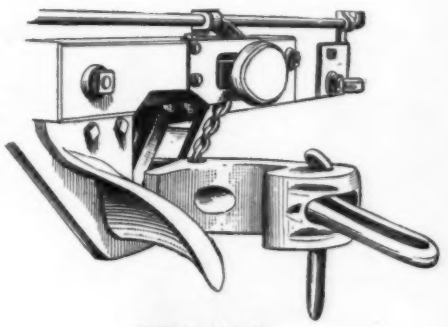
TITUS & BOSSINGER—ADOPTED.



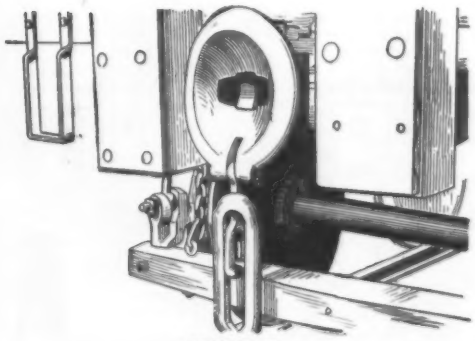
COWELL—ADOPTED.



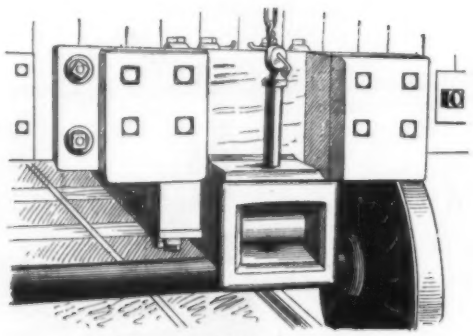
UNION.



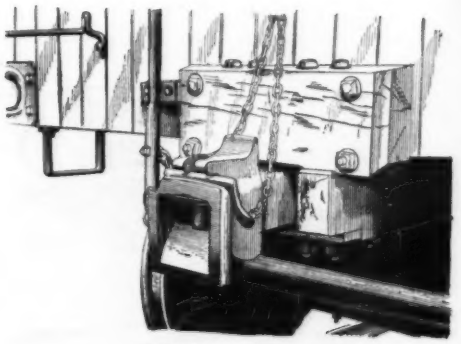
HITCHCOCK.



SMILLIE.



RUSSELL'S ECCENTRIC.



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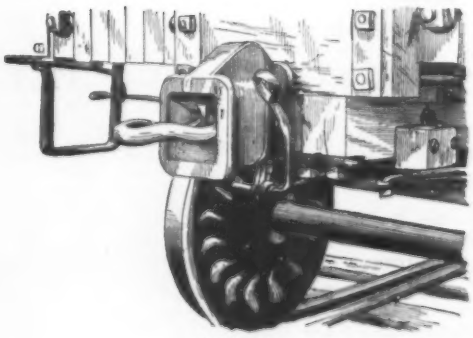

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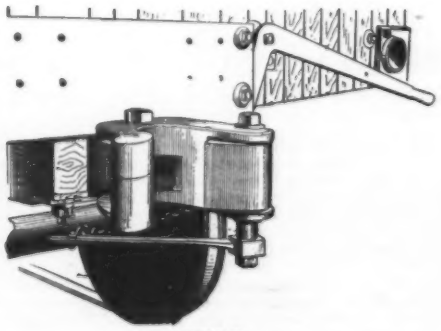
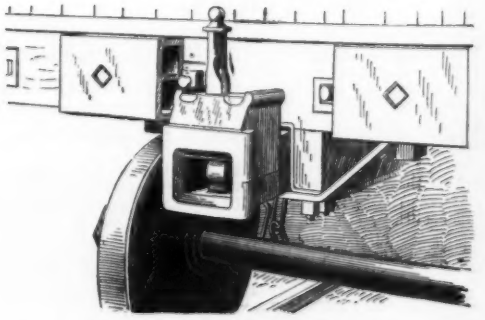
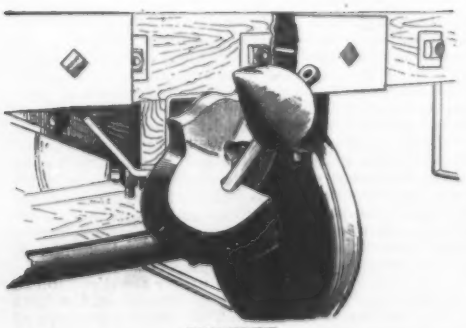


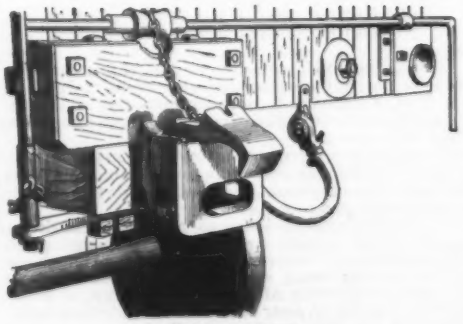
HILLS.



EUREKA.



EMMETT.



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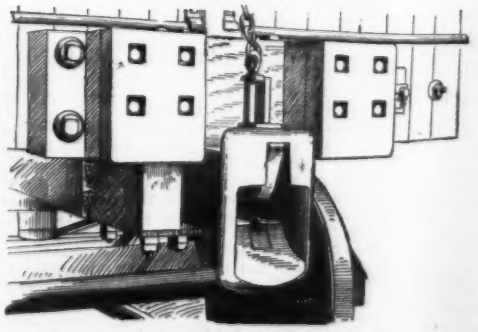
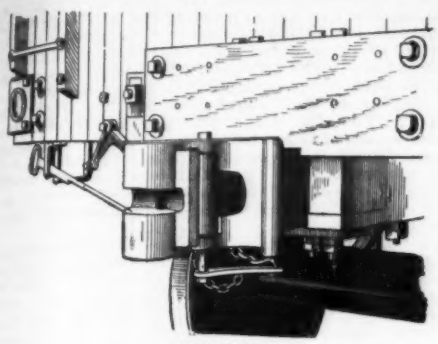
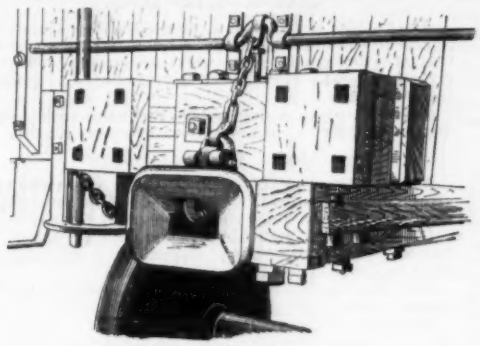


UNITED STATES.

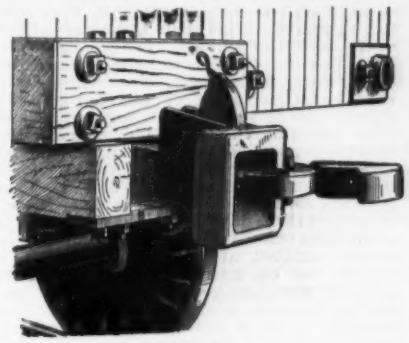
THE AUTOMATIC CAR COUPLERS TESTED AT BUFFALO, SEPT. 15-17, 1885, BY THE EXECUTIVE COMMITTEE OF THE MASTER CAR-BUILDERS' ASSOCIATION.



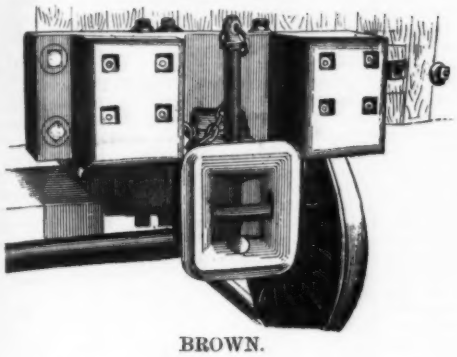
MULLER.



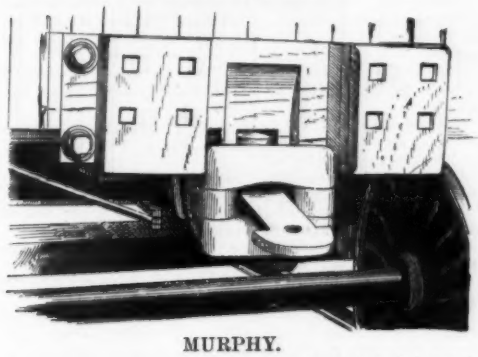
CURTIS & WOOD.



WILLIAMS.



BROWN.



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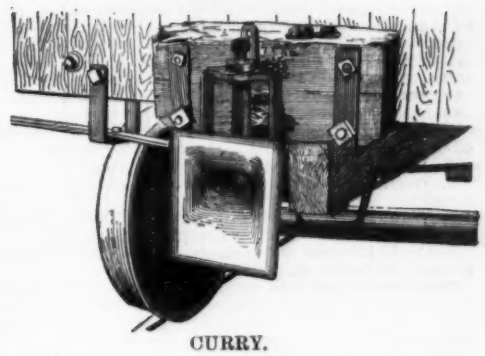

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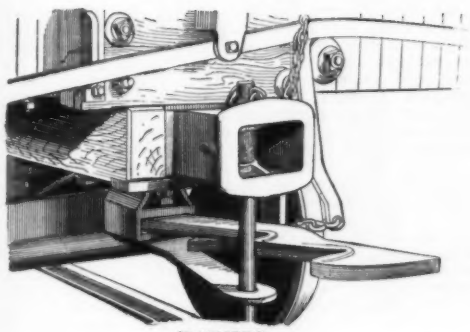

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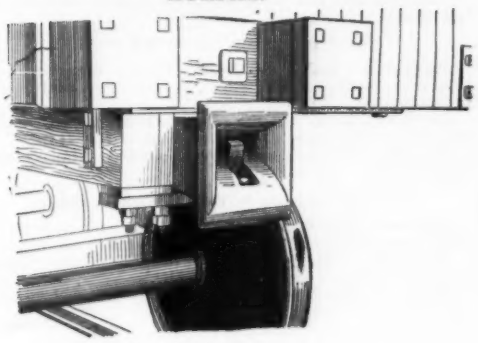

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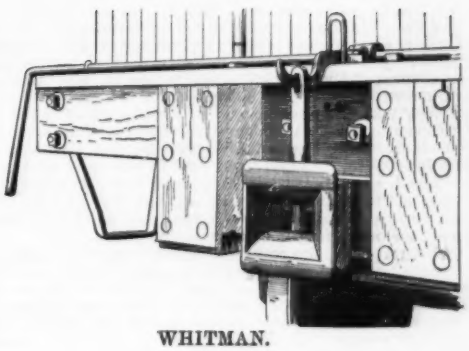
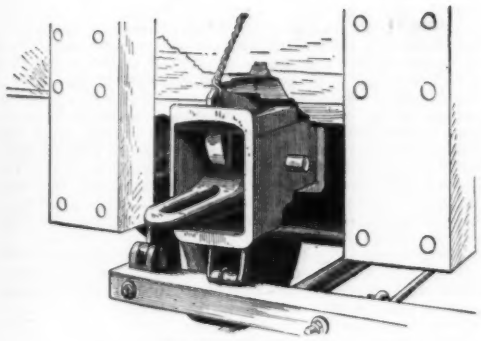
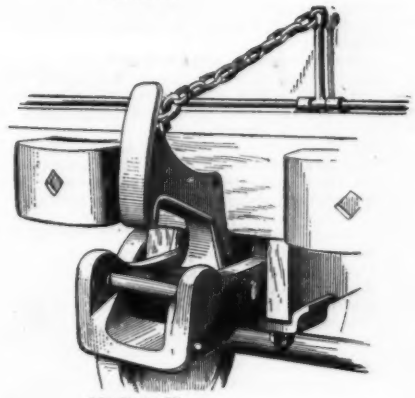


WHITMAN.



STANFORD.



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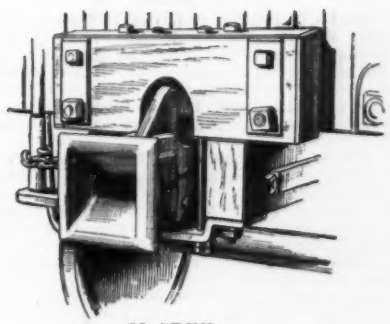

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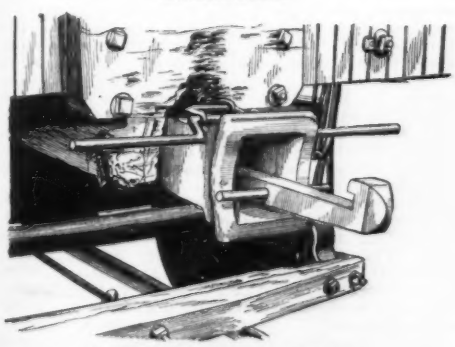
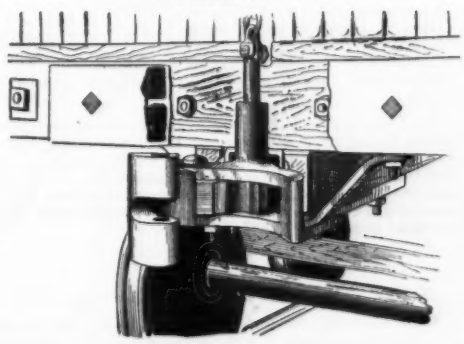
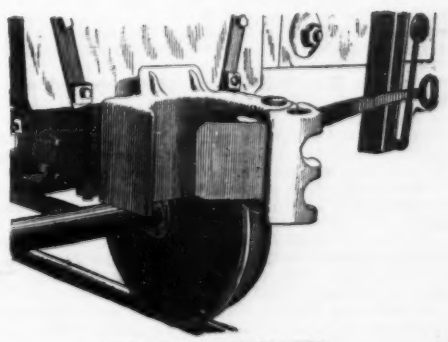


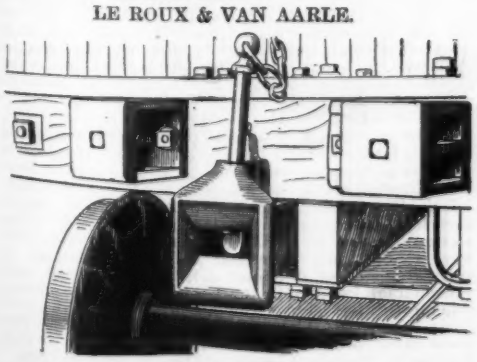
LE ROUX & VAN AARLE.



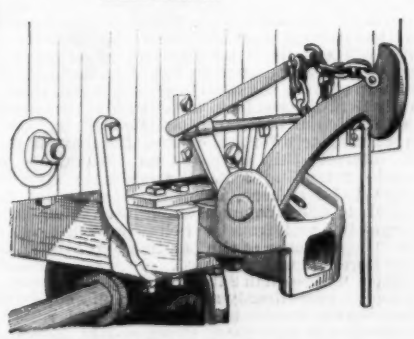
SIMPSON'S.



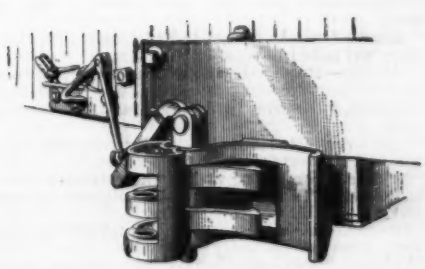
BOSTON AUTOMATIC.



BIRD.



MEADOWS & MEAD.



JOO.

THE AUTOMATIC CAR COUPLERS TESTED AT BUFFALO, SEPT. 15-17, 1885, BY THE EXECUTIVE COMMITTEE OF THE MASTER CAR-BUILDERS' ASSOCIATION.

were all of them well posted in regard to the requirements of a good car coupler, and were able therefore to give an intelligent and appreciative attention to all of the devices submitted. The management of the entire series of tests seems to have given general satisfaction. Two points, however, were not brought out as clearly as they might have been, and have caused some comment. The ease with which one coupler would couple with other automatic couplers, an important consideration, was not investigated at all, and the relative convenience with which the improved devices would couple with the ordinary link and draw-head was but partially considered. But as it was, the actual trials consumed three days, on account of the large number of couplers presented. Had a preliminary test reduced the number, at least a dozen would have been thrown out on good and sufficient grounds. Six couplers were damaged or broken while in transit or during the trials, while some could not be uncoupled without the aid of tools, and one came uncoupled five times in a very short distance.

The first series of tests was conducted on a straight and level piece of track, or a level tangent, in the yards of the New York, Lake Erie, and Western. The engine employed was about equal in power to an American eight-wheel freight engine, or but half as powerful as one of the Consolidation type, so that the cars were not subjected to as severe blows and shocks as might be expected in actual service.

The Committee endeavored to ascertain the behavior of each coupler in regard to the following points:

1. Would it couple with the standard link?
2. Would it couple with its own kind at a slow speed?
3. Would it couple with its own kind when the two cars were brought together sharply]? and finally,
4. Could it be set *not* to couple when the cars were brought together sharply?

Some confusion was occasioned by a want of uniformity in the idea as to what constituted a standard link. The one used was 10½ by 1¾ inches inside measurement, D-shaped section, and 1½ inch iron. Many of the competitors employed a link 2 inches wide on the inside, and considered that to be the Master Car-Builders' standard, while the Erie standard, as stated by Mr. Wilder, was 11¾ by 1⅝ inches inside measurement. This undoubtedly led to a failure on the part of several of the couplers to engage with the ordinary link, and was much to be regretted. Considerable difficulty was also experienced in the classification of the different designs, as in several, changes of an essential character had been made, and placed the coupler under a different class from that in which it had been entered. The materials employed were likewise variable in the two couplers submitted, but this was not an important point in an experimental device, however serious it might be in practice.

A number of the couplers, which stood the tests admirably on the tangent, failed entirely when tried on an inclined curve. This second series of trials was consequently regarded as much more conclusive. It was carried out on a 20° 20′ curve (282 feet radius), and with the center of the draw-bar of one car 3 inches above the corresponding point in the other car.

The following is a brief description of the couplers examined, and the record made during the tests:

CLASS A.—LOOSE LINKS.

Bird.—Provided with dead block and buffer; the pin supported and the link kept horizontal by a spring plunger. Operates by gravity and spring, is entirely automatic, and satisfied all the tests.

Brown.—Provided with dead block, but no buffer; the pin supported by side-pivoted wing, which is pushed aside by a link. Operates by gravity. Results not satisfactory.

Curry.—Without dead block or buffer; the pin guided by side rods. Operates by gravity. Unsatisfactory results.

Eureka.—Provided with both dead block and buffer; the pin supported by a dog. Operates by gravity with satisfactory results.

McKeen.—Provided with dead block, but no buffer; the pin supported by a spring plunger, and the link guided by a patent controller. Couples with the old style by hand, but is otherwise automatic. Results very satisfactory.

Perry.—Also provided with dead block, but no buffer; the pin supported by a dog, and the link guided. Operates by a spring. Couples with the old style by hand, but is otherwise automatic, and works well.

Russell's Eccentric.—Has a pin supported by a rolling eccentric. Operates by gravity, and stood the tests well.

Smillie.—Has a pin supported by a spring plunger, and a special link attached to a draw-head. Operates by a spring, and gave satisfactory results.

Whitman.—Has a special form of pin, and operates by gravity. The draw-head broke in half in switching.

Archer.—Provided with dead block, but no buffer, and has a long vertical hook inside the draw-head instead of a pin. Operates by a spring. Entirely automatic, and works well.

Curtis and Wood.—Has a dog actuated by gravity and a spring, and is locked by a spring. The pattern was faulty, so that the results were not good.

Gifford.—Provided with a buffer; has loose link, and a pin which can be set not to couple, but cannot be removed from draw-head. Automatic, and gave good results.

Keily.—Has loose link and gravity dog. Worked well.

Lancaster.—Also provided with loose link and gravity dog, but failed in passing the tests.

Marks.—Provided with a dead block, but no buffer; has a long vertical hook raised by an eccentric; operates by a spring; automatic, and gave very good results.

Mc Cree.—Has loose link and gravity dog, but did not pass all the tests.

Payne.—Has a dog which when struck by a link engages with the same. Must be coupled by hand with old style. Did not work well.

Union.—Also has a loose link and gravity dog. The tests were but partially conclusive.

United States.—Has a fixed pin with an inclined dog attached, which is lifted when struck by a loose link. Operates by gravity.

CLASS B.—FIXED LINKS.

Ames.—Has a fixed link, pivoted at the center, balanced at the inner end, and a hook on its under side Operates by gravity, and must be coupled with old style by hand. May be set not to couple by pushing the links back.

Stanford.—Has a dog above the fixed link. Operates by gravity. Did not give satisfactory results.

CLASS C.—VERTICAL PLANE.

Boston.—Has knuckle locked by a notch in the operating lever. Operates by gravity. Must be coupled by hand with the old style. Gave good results.

Dowling.—Has knuckle opened by a spring and locked by a vertical key. Operates by gravity, and must be coupled with old style by hand.

Joo.—Has knuckle locked by a piece swinging in a vertical transverse plane. Gave satisfactory results.

Simpson.—Has the knuckle locked by a vertical pin. A very recent invention, and hardly finished enough for trial.

Thurmond.—Has knuckle locked by a piece sliding forward and downward. Operates by gravity. Must be coupled with old style by hand. Gave good results.

Hien.—Has knuckle opened by a spring locked by a vertical piece. Both knuckles move to couple or uncouple.

Hill's.—Has knuckle kept in coupling position by a spring, and is uncoupled by a lever. Became badly broken during the tests.

Janney.—Has knuckle locked by a vertical plunger actuated by a spring. Excellent results.

Muller.—Has knuckle actuated by a spring and a cam. Required two men to manipulate levers.

Cowell.—Has knuckle locked by gravity. Entirely automatic, and works well.

Hitchcock.—The draw-head moves sideways up an inclined plane to uncouple. Did not work well.

Titus and Bossinger.—Has a knuckle locked on the outside by a radial cam falling vertically. Operates by a spring and gravity. Is a little slow in coupling at low speeds.

CLASS D.—LOOSE COUPLING BARS.

Fitzgerald and Van Dorn.—Has a coupling bar hook-shaped at one end, a link at the other, and a pin in the center. Worked well.

Le Roux and Van Aarle.—Has a coupling bar hoop-shaped at both ends. Failed in some of the tests.

Murphy.—Has a coupling bar barbed at both ends. Good results.

CLASS E.—HOOKS ROTATING VERTICALLY.

Hilliard.—Has wide hooks above the ordinary draw-head; operates by gravity. Did not satisfy all tests.

Meadows.—Has right and left handed hooks. Operates by gravity. Failed to pass all the tests.

Morgan.—Also has right and left handed hooks. Worked well.

UNCLASSIFIED.

Barnes.—Has hooks rotating in horizontal plane beneath the ordinary draw-head. Operates by a spring and gave good results, though the draught bolt became broken.

Emmett.—Has a screw clutch turning on horizontal axis. Would not uncouple pinch-bar as required.

Williams.—Has a hook rotating in the horizontal plane, engaging the side of the draw-head. Uncoupled repeatedly on curve.

At the end of the trials, and after several hours' deliberation with closed doors, the Committee announced that they had decided to recommend the following couplers for further trial in actual service:

CLASS A.—LOOSE LINK.

McKeen, A 1, pin supporters.
Perry, A 1, pin supporters.
Archer, A 2, catch or dog in place of pin.
Gifford, A 2, catch or dog in place of pin.
Marks, A 2, catch or dog in place of pin.

CLASS B —FIXED LINK.

Ames.

CLASS C.—VERTICAL PLANE.

Dowling, C 1, gravity lock.
Thurmond, C 1, gravity lock.
Hien, C 2, locked by a spring.
Janney, C 2, locked by a spring.
Cowell, C 3, draw-bar guided by "boot."
Titus and Bossinger, C 3, draw-bar guided by "boot."

It will be noticed that of the twelve couplers selected by the Committee, six were of the link style, and six coupled in the vertical plane. During the months which elapse before the further meetings of the next convention of the Association, these couplers will be carefully watched, and their performance will decide the final verdict of the Committee.

[ENGINEERING.]

THE CLINOGRAPH, OR BOREHOLE TEST.

SOME time ago we published an interesting communication respecting a lost borehole at the Holyrood Brewery, Edinburgh, where a very ingenious method was adopted of finding the approximate position of the bore. It had become desirable—doubtless because of that natural want of faith in the absolute straightness of the path of the diamond or other drill which every practical man must feel—to ascertain, by means of a drive from the bottom of a well 200 ft. deep, and only 18 ft. distant from the mouth of the presumably perpendicular bore, whether the drill had pursued an approximately vertical course. The drive having failed to intersect this, although an excavation had been made extending 3 ft. all around the spot where it should have been, bar magnets were let down the borehole and a compass taken into the adjoining drive or gallery, and, from the behavior of this compass under the influence of the bar magnets, the position of the borehole was indicated. It was eventually intersected, no less than 8 ft. away from its theoretical path, which is gratuitously assumed by diamond drill manufacturers to be absolutely straight and true. Such a deflection at only 200 ft. depth would indicate a probable error of at least 40 ft. in 500 ft., and increasing in geometrical ratio, as can be easily proved by holding a straight steel wire, such as a very fine knitting needle, stiffly against the edge of a foot rule or graduated scale at one end, and lifting the other end of the needle until, at 200 parts on the scale, the needle deflects eight of these parts. The deflection at the end lifted, which is at 500 parts (representing 500 ft.), will be found to err, roughly, by the amount stated, namely, 40 parts or feet. In fact, the reader will perceive at once the serious aspect of these deflections; they are increasing errors. If at 50 ft. the error is 2 deg., at 100 ft. it is 4 deg. or more, at 150 ft. it is 6 deg. or 8 deg., and it will pursue a curve of more or less regularity until it returns upon itself, unless the deflecting influences sooner terminate.

It is not very wonderful, therefore, that the common belief in the capacity of diamond drills to bore a straight hole through hundreds of feet of strata of varying densities, and standing or lying at every possible angle to the line of bore, has during the past two or three years been severely shaken. At various places, and notably at Sandhurst and Stawell, in the province of Victoria, Australia, where costly operations were in several instances rendered necessary by a mistaken confidence in the rectitude of drills, the bores made by these implements were found to have deviated so seriously from their initial direction as to imply errors amounting to from 50 ft. to 75 ft. in boreholes of 500 feet. Inquiries recently made in California and other mining States have elicited the fact of grave deflections involving large outlay, and great perplexity having occurred there also. In fact, wherever a drill has touched payable stone, and wherever the results, therefore, had to be mined for, the search for them has been protracted, bewildering, and expensive; and in every case the borehole and the mineral deposits touched by the drill have been found at a considerable distance from where they should have been. Hence the unpopularity of diamond drills among those who stand most in need of their assistance in prospecting; and hence the necessity of devising some method of detecting their deviations, and of turning their vagaries to useful account by reducing them to rule and measure.

Mr. E. F. Macgeorge, of Victoria, devised a simple and delicate, yet effective, means of making a survey of the borehole from its origin, and we have prepared engravings of the latest form of Mr. Macgeorge's exceedingly ingenious apparatus, and we now publish a detailed account of its construction and operation. The part that is inserted in the borehole will be found illustrated in Figs. 1 and 3 to 6, and the instrument by which the indications are read off in Fig. 7.

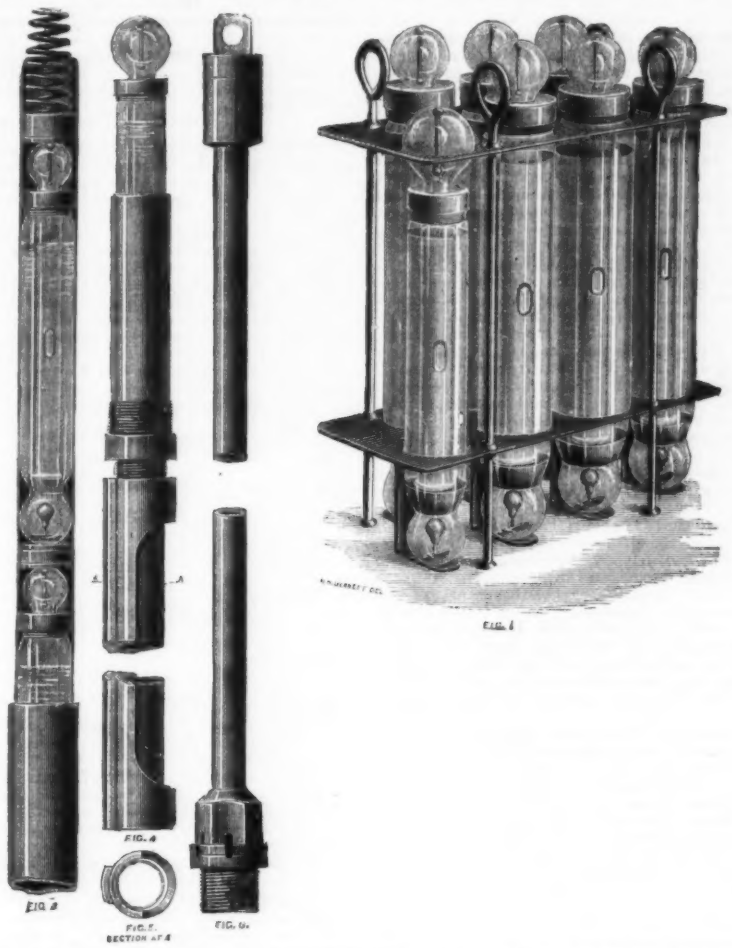
Clear glass phials (Fig. 1) nearly filled with a hot solution of gelatine, and each containing a magnetic needle in suspension, free to assume the meridian direction, were encased in a brass protecting tube (Fig. 3) and let down to the depth required, being allowed to remain for several hours until the gelatine had set. On withdrawal the phials could each be replaced at the same angle at which they had cooled, by means of the congealed surface seen through the sides of the phial, and which was brought horizontal. Revolving the phial upon the part where the magnetic needle was seen embedded in the gelatine, until the needle again was in the meridian, the phial then was manifestly in the same position, both as regards inclination and azimuth, as it was when its contents congealed; and thus the gradient and bearings of the borehole at that part were known, and soon were measured by means of a rough and ready angular instrument constructed by the inventor. The mean of the several phials gave a still more accurate result. By repeating this operation at measured intervals throughout the borehole, its course was mapped. Such was the device that was first brought into use in the Scotchman s United Mine at Stawell, and which was so effectual as to enable the borehole to be found shortly afterward, 37 ft. away from its supposed position, at the depth of 370 ft., a deflection which increased to the large amount of 75 ft. at the depth of 500 ft.

Scotchman's United Mine.—The most obvious waste of work is where the drill has passed through a lode or reef, and where a drive or a shaft, having been carried on for some scores or some hundreds of feet in the supposed direction of the borehole, fails to come within sight or sound of it, and where, after passing far beyond where it should be found, and putting forth crosscuts to intercept it, the prospectors are finally compelled to cut huge chambers in various directions without success. This was done in the above mine at Stawell, before the borehole was found, as indicated by the test, nearly two score feet away from its proper position, in little more than two-thirds of its full depth. This is a serious waste of time and money; yet similar mishaps have more than once taken place, and will continue to do so until mine owners substitute survey for random and costly search. The exact data are given in Fig. 2.

In the plan of the workings will be seen the exploring level, A B, which failed to find the borehole at B, its theoretical position if the drill had gone straight down. The subsequent exploratory workings, B F, B D, B E, D G, were huge galleries 15 ft. to 30 ft. wide, and the miners were working hopelessly at G when the clinograph was invented and applied, with the result that the true site of the bore was shown to be at C. The government mining surveyor, who had applied the test at the request of the inventor, then laid off the line, B C, upon which the search works were then directed, with the result that the borehole was found, as predicted, no less than 37½ feet away from its proper position, and in a contrary direction to all previous workings. These operations were conducted over a period of twelve months at the heavy cost of 3,663*l*. Had the clinograph been available before commencing the long level, it would have indicated the true site of the bore at C, and the level or gallery would have been directed along the line A C, at a total cost of only 1,352*l*. The saving here by using the test would therefore have been no less than 2,311*l*. The section shows at B B the path which the drill was theoretically supposed to take, according to the statements of diamond drill manufacturers, and the common belief of drill operators, while the curved line on the left shows the actual path of the drill down to the part, C, where the bore was found. The same curve, prolonged to the depth of the bore, which was 500 ft., the usual length of the "prospecting drill," gives a deflection at that depth of no less than 75 ft. Yet no unusual difficulties were experienced in putting

down this bore, and apparently it might have deflected twice as much without endangering the drill.

Subsequent trials were made with the same apparatus in the Crown Cross United Mine at Stawell before completing an intended drive toward a reef pierced by the diamond drill; and the drive, being altered to intercept the real course of the drill—ascertained by the use of this invention to be 18 ft. away from the straight



MACGEORGE'S BOREHOLE SURVEYING APPARATUS.

at less than 300 ft. depth—intersected it fairly in the middle of the drive, and exactly in the direction indicated by the test. As the indications of the congealed surfaces within the phials were found to be unsatisfactory, owing to the effects of capillarity and unequal adhesions to the sides of these cylindrical vessels, as also to the action of unequal refractions through the glass, the inventor determined to adopt another expedient, by which a perpendicular line or plummet, free during liquidity, and fixed on congelation of the

FIG. 7.—MACGEORGE'S CLINOMETER.

solidifiant fluid used, was substituted for the horizontal surface indication. At the same time the magnet was rendered far more delicate and reliable in all possible inclinations of borehole, and the form of the phial was determined finally as follows:

The Phials or Clinostats.—The construction of these can be readily seen in the engraving, Fig. 1, which shows the position of the magnets and plummets, while the phials are hot and vertical. If inclined, say to an angle of 45 deg., the plumb rods, still vertical, would occupy the then uppermost part of their containing spheres, while the magnets, still horizontal and free, would rest vertically upon their pivots in the then lowest portion of their containing spheres. (The short clinostat in front is that belonging to the core extractor, Fig. 4, where it is seen within its cell, the upper bulb only being visible. For this reason the plummet is supplied with a minute compass needle, set in its hollow spherical head, and which supplies the bearing required.) The clinostat is a true cylinder of glass, as to its central part or barrel, so as to fit accurately within the brass guide tube. At the lower end, the phial terminates in a short neck and a bulb, within which latter a magnetic needle is so held up by a glass float as to stand upright upon its pivot, like a top upon its peg, in every position of the phial, and thus allow the needle, which is fixed upon its "peg," to assume the meridian freely at all times without touching the sides of the hollow bulb. Passed through an air tight cork and screw capsule at the upper end, is a small glass tube terminating in another bulb above, and with its open lower end inserted in a cork which enters the lower neck of the phial; thus preventing the escape of the needle and float already mentioned as occupying the lower bulb.

The upper bulb contains a delicate plumb rod of glass, consisting of a fine rod terminating in a plumb of solid glass below and in a diminutive bulbous float of hollow glass above. It is very carefully adjusted to the specific gravity of the solidifying fluid in which it, like the magnet, is immersed, and then its poise is so adjusted as to insure that the rod or shaft shall be

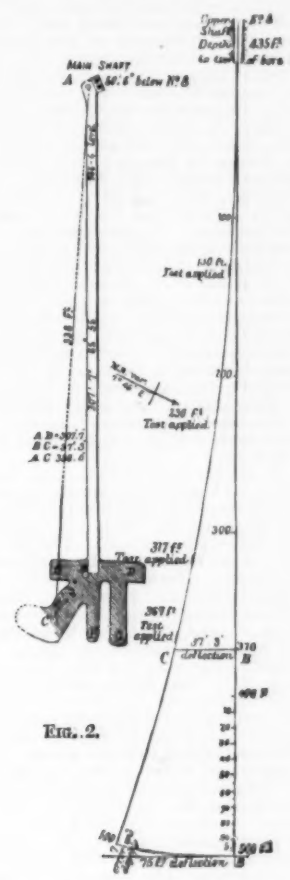


FIG. 2.

truly in the perpendicular line, whatever the position of the phial and bulb may be. While fluid, the contents of each phial (which completely fill both upper and lower bulbs) permit the plummet to hang freely perpendicular in the center of its chamber, and allow the needle in the lower bulb to assume with the utmost delicacy the magnetic meridian; but when the phial is at rest in any position, from vertical to horizontal, and pointing to whatever quarter of the compass as it inclines, the contents solidify in cooling, and by this means grasp and hold fast the indicating plummet and magnet, embedding them, like the "fly in amber," in solid transparent substance. The phial then contains within itself an automatic registration of the inclination and azimuth at which it set while (let us say) 500 ft. deep in the borehole to be tested; and it is easy, therefore, after its withdrawal, to tilt it to the same angle and to the same quarter of the compass as before by simply bringing the embedded plummet to the vertical, and the needle to the northerly, direction. The whole contrivance is in principle, indeed, simplicity itself; but the reduction of these principles to practice, owing to the extreme delicacy of manufacture requisite to obtain reliable results and to the great difficulties in the way of obtaining intelligent, accurate, and delicate workmanship in glass in the colonies—difficulties which for a long time drove the inventor to be his own manufacturer—proved a work of time, of ceaseless expenditure, and of patience. These clinostats are heated, inclosed within their brass protecting tube, lowered by rods or a line to that part of the borehole which it is desired to test, their contents allowed to cool and congeal, and are withdrawn for inspection, so that their inclination and azimuth at the time of congealing may be exactly determined.

The Clinometer or Recording Instrument.—This cannot better be described than by a comparison with the well-known theodolite. If we could introduce a theodolite into a borehole, together with an observer to record the angles, vertical and horizontal, as read off on the graduated circles, there would be no need for the gelatine phials. But as the ordinary borehole is less than two inches in diameter, although five hundred feet in depth, we could at the best only put the telescope of the instrument down to the desired distance. Let us suppose that such a telescope, by some magic, had the power, when restored to its place in the theodolite, of replacing itself at the same altitude, and of looking to the same quarter of the compass, as when down in the borehole; then we should have nothing to do but to read the graduated circles as if we were making a direct observation, and note them. The phial or clinostat already described is just such a magic telescope, and when replaced in the recording instrument is readily set, by means of the imprisoned plummet and magnetic needle, in the same direction, both as to altitude and azimuth, which it had previously assumed while in the borehole and far separated from the observer's eye and control. The *modus operandi* is as follows:

The phial with its congealed contents is placed in a sheath of brass tubing (Fig. 7), attached to a movable arm which carries the index of a vertical arc. This

sheath corresponds with the Y's of a theodolite, and carries the phial firmly upon the same principle as these carry the usual telescope. The upper bulb of the phial is brought into the field of two cross visioned microscopes, which are carried with the arm around the vertical arc, and which are kept truly in the same plane at every angle of inclination by a parallel motion. There are vertical lines drawn upon the object glass of each microscope, these being, of course, kept truly vertical by the parallel motion just mentioned. The phial is revolved in its sheath, and the arm is moved along the arc by the tangent worm, until the embedded plummet is made perpendicular from each point of view, or parallel with the vertical lines of reference just described, as viewed through the two cross telescopes. The phial is now at the same angle of inclination at which its contents solidified, and its lower bulb will be found nearly in the axis of the revolving arm and an inch or more above the center of a horizontal revolving circular mirror, having a system of parallel lines engraved across its face. Reflected in the mirror will be seen the image of the embedded needle, which, as we know, pointed north before it was fixed by congelation in the borehole. If we now revolve the mirror until the 270 deg. of the graduated circle is opposite the north (or notched) end of the needle, and until the reflected image of the needle is sensibly parallel with the engraved lines, an index at the side of the graduated mirror frame will give the exact angle between the needle and the vertical plane of revolution of the phial, which is, in fact, the magnetic bearing of the inclined phial and of the borehole which it occupied at the time of the application of the test. The same operation is repeated with the other five phials which complete the set, and then the results are combined and the mean taken in the same manner as if six separate determinations of the same horizontal angle and azimuth had been made with a theodolite or an altazimuth instrument. These six phials—or "self-registering compass clinometers" as they may be termed—are encased within and protected by the cylinder or guide tube.

Cylinder or Guide Tube.—This is a strong brass tube, about 6 ft. in length, into which the phials accurately fit (as will be seen on reference to Fig. 3, which shows part of its upper end with the phials in their brass slide in the act of entering). This tube or cylinder is securely closed against the heaviest water pressure likely to be encountered even in bores of 2,000 ft. depth; the glass clinostats being of too fragile a construction to bear exposure unprotected to such a pressure. The guide tube is passed down the bore by means of half-inch diameter service piping jointed in measured lengths, the effect of the iron being kept from the magnets by the interposition of a distance tube of brass, terminated by the solid plug which screws into the upper end of the guide tube (see Fig. 6). For use in hot strata, where cold water must be poured down this small piping in order to cool the cylinder below, the upper part of this solid plug is pierced with holes out of which the cooling stream from the tubing may issue and flow down the outside of the cylinder, thus congealing its contents. Where the bore is approximately perpendicular, and the strata comparatively cool, these may be dispensed with, and the survey of the bore be accomplished by lowering the guide tube with small wire rope. The eye, which replaces the iron pipe, and screws into the upper end of the distance piece, as seen in Fig. 6, being provided for that purpose. Where the bore approaches the horizontal, as in testing ground ahead of drives or levels in mines, the iron piping or "application rods" must be used to force the guide tube to the desired distance; and in any case these must be employed where it is desired to extract a piece of standing core with the test attached. This is an easy and certain way of obtaining, not only the true direction of the borehole, but also the true dip and strike, underlie and bearings of strata, lodes, reefs, and deposits of all kinds. To accomplish this desirable end, there may be affixed to the lower end of the guide tube (in such fashion as to close it hermetically and at the same time grasp one of the phials within it) a contrivance termed the core extractor (see Fig. 4).

Core Extractor.—This is a brass tube set eccentrically, and furnished with a bell-mouth below, the office of which is to receive the extremity of any piece of core left standing at the bottom of the bore, and, as the apparatus is forced down, to press on one side and break off the piece of core. The core extractor, which is of brass, contains a spring-like inner tube, slotted from end to end, which expands as the core enters, and grasps it firmly. The whole apparatus being now left unmoved for two or three hours, until the fluid in the phials has cooled and set, is withdrawn, and the core extractor unscrewed. At the lower end of this will be found the core (projecting beyond the lower end of Fig. 4, but not shown in engraving), at the other a phial, both of these being firmly grasped and kept in the same relative situations as in the borehole. The phial, by means of its internal indications, will enable the piece of core to be replaced in its natural position for observation, and thus there may be readily ascertained (by examination of the markings) the true dip and strike of the strata, or the underlie and bearing of the reef, of which it originally formed a part. The importance, not only to geologists but to miners, of this information, will be readily acknowledged. At the same time the other five or six phials join with this one in affording very exactly the inclination and bearing of the borehole at that part, and by a series of such observations, say at every 50 ft. of boring, information could be obtained, nearly as useful and complete as if from a prospecting shaft, or level, or winze, and at a fraction of the cost. And there would be a direct saving also in bores. For example, the Magdala Mine, at Stawell, in one bore pierced an auriferous reef. Partly because the underlie and bearings of the reef could not be ascertained from cores which, of course, had been whirled round the compass many times before extraction, and partly because the rectitude of the path of the drill, from former experiences, was distrusted, the directors decided to put down a check bore at some distance to intersect the reef. This bore cost between 500*l.* and 1,000*l.* according to the general average of boring, and yet a previous application of the test and core extractor would have rendered it quite unnecessary. This is but one of many instances of a like nature, both in reef and alluvial boring, where hundreds of pounds have been spent in the absence of apparatus such as that just now described, and which has been submitted for our inspection.

[Continued from Supplement, No. 509, page 8136.]

ON THE CONSTRUCTION OF ROLLING CAMS AND SYMMETRICAL LOBED WHEELS.

By Professor C. W. MacCord, Sc.D.

II.

The circumstance that the contours of a pair of rolling cams are but parts of the pitch lines of a pair of non-circular wheels, was mentioned in the preceding article. Indeed, it is a sufficiently familiar fact that teeth are added to circular wheels only because without them the rotation of the follower would not be compulsory, since the contact radius of the driver is constant; and not because the pitch circles roll together without sliding. In the rolling cam, on the other hand, the rotation is compulsory because the contact radius of the driver is on the increase; and the more rapidly it increases, the more perfect is the driving action, the flatter is the curve, and the more acute is the intersection with the line of centers; while if the rate of increase be slow, the curve approaches more nearly to the form of a circle cutting the line of centers normally: and consequently the driving action becomes less pronounced, so that, as already pointed out, it may become necessary to make use of teeth in order to maintain it at all. And it is quite apparent that if teeth be provided on the whole contour, the driver may be turned in either direction, as well as that, if this contour be a curve that returns into itself, like the ellipse, the rotation may be continuously maintained without reversal.

And even if it be not, this is still possible under some conditions. Thus in Fig. 16, the acting outlines are arcs of the logarithmic spiral, which is not a closed curve, yet it is apparent that if both these lobed wheels be provided with teeth, either of them will drive the other continuously in either direction. Considering the upper one as the driver, and supposing the rotation to be always in the direction of the arrow, it will be seen that teeth would be necessary on only one side of each lobe; PA would drive PB until A and B meet on the line of centers, but AF would not drive BG. Now, PDA and PCB are simply two rolling cams, or spiral sectors, precisely like those discussed in the preceding article, and ADF, PCE, are merely the same sectors reversed.

In this way it is clear that from any given pair of rolling cams, a pair of lobed wheels may be constructed by repeating their contours in alternate reversion; provided that the total angle subtended by each at the center be contained in the circumference an *even* number of times. When this is the case, the conditions, so far as the angular movements are concerned, may often be satisfied by the direct construction of elliptical arcs. Take for instance the angles of 60° and 45° as in Fig. 16; then in Fig. 17 take any two points as D, O, for the foci, make the angle PDA = 60° and the angle POA =45°, and the intersection A of these lines is a point on the ellipse whose major axis PH is equal to AO + AD; the angle PCB at the farther focus of its rolling mate will be equal to POA, that is, 45°, if we set off PB equal to PA; so that PDA, PCB, are a pair of rolling cams, and the trilobe and quadrilobe are completed by simple repetition of the arcs PA, PB, as above explained. But the velocity ratio is determined by the eccentricity of the ellipse, and will vary between the limits $\frac{PD}{PC}$, $\frac{DA}{BC}$, neither of which is arbitrary if this process be adopted.

Of course if these sectors be employed as cams, teeth will be necessary as previously pointed out, at least at the first parts of the arcs PA and PB; and this figure serves well to illustrate the fact that while there is this close relationship, indeed absolute theoretical identity, between the rolling cam and the lobed wheel, yet the better suited a curve is for one purpose, the worse it is for the other. The flatter the curve and the more rapid the increase of the contact radius, the better is the driving action in one direction of the toothless cam; but the same curve, if the lobed wheel be completed, must drive in the opposite direction by the aid of its teeth only, and the obliquity of their action becomes less the more nearly normal the contact radius is to the pitch line. Keeping this in mind, then, we proceed, not to discuss the construction of lobed wheels in general, but to consider one or two processes which are applicable both to them and to cams which may not constitute exact lobes.

In Fig. 18, the angles ADP, AOP, are to each other in the same *ratio* as in the preceding diagram, viz., that of 4 to 3; HP is equal to AO + AD, and making the elliptical arc PB equal to PA, we have two sectors which will roll together as before about the foci D, C.

Now if ADP be contracted until it becomes equal to 60°, and BCP be contracted in the *same proportion*, the latter will evidently become 45°; the new curves PK, PL, will still roll together, and we may construct by repeating them another pair of symmetrical but dissimilar lobed wheels, the velocity ratio now varying between the limits $\frac{PD}{PC}$, $\frac{AO}{OD}$, which values are different from those of Fig. 17, supposing the distance CD between centers to be the same in each case.

In this way it is evident that a great number of different ellipses can be made, from each of which a pair of rolling cams or a pair of lobed wheels may be derived; but if we assume the angles ADO and AOD, neither value of the velocity ratio can be assigned, for both depend upon the eccentricity of the resulting ellipse.

Now of course there must be a determinate relation between this eccentricity, the angular motions, and the limiting values; if three of these five elements be given, the other two will be thereby determined; and even in assigning the three, it will be seen that there are restrictions beyond which we cannot go without rendering the solution impossible.

In Fig. 19, the curve AGBD is determined as follows: Assuming any two points A, C, upon the indefinite line HD, construct the angles BCD, BAD, having to each other any given ratio, say that of m to n, m being the greater, then the intersection B of the lines making these angles with HD will lie upon the curve; similarly let ICD be to IAD as m to n, then I is a point of the curve, and so on. Since the intersections may become so acute as to render the exact location of the points unreliable, the following property may be made use of to fix them more precisely. The center of the circle circumscribing any one of the triangles whose base is AC and vertex in the curve, as for instance ABC, must lie on the line LM perpendicular to and bisecting AC.

Then we have:

$$BCD = m,$$
$$BAC = n,$$
$$ABC = m - n.$$

And in the circumscribing circle we have:

$m - n$ measured by ½ arc AC,
n " " ½ arc CB,
m " " ½ arc ACB,

that is to say,

$$\text{arc CB} : \text{arc AC} :: n : m - n.$$

If then we had taken the center O at pleasure on LM, and, describing the circle through A and C, had set off the arc CB in the above ratio to AC, the point B would have been thus located without drawing the lines BA, BC.

This curve springs from the point A; for when m becomes 180°, the arc ACB must equal the whole circumference, so that the point B will fall at A; AC will then divide the *circumference* into two segments such that the one above the line will be to the one below it as n is to $m - n$, and the curve will be tangent at A to the circle whose diameter is thus determined.

The limit D of the curve will be reached when m becomes zero, that is, when the center O is infinitely remote and the circumference coincides with the right line ACD. By analogy we then have:

$$CD = AC\left(\frac{n}{m-n}\right),$$

but
$$AD + CD = 2\,CD + AC,$$
$$= 2\,AC\left(\frac{n}{m-n}\right) + AC$$
$$= AC\left(\frac{2n}{m-n} + 1\right)$$

or,
$$AD + CD = AC\left(\frac{m+n}{m-n}\right),$$

whence
$$\frac{AC}{AD + CD} = \frac{m-n}{m+n}.$$

Now if from any point, as E, upon this curve we draw lines to A and C, the angles ECD, EAD will be to each other in the ratio of the original magnitudes m and n, and the sum EA + EC being taken as the major axis HP of an ellipse of which A and C are the foci, the arc PE will, evidently, be the contour of one of a pair of cams which will roll together as in Fig 17; and a pair of lobed wheels may be formed from them by expansion or contraction if the ratio of m to n be that of two whole numbers. And conversely, if A and C be taken as the foci, any ellipse which cuts the curve will by that intersection determine an elliptical arc that may be thus employed in the construction of either the cams or the lobed wheels; and it is now clear that the extremity P of the major axis must lie between C and D.

If then the numbers of lobes of two proposed wheels, or the angular motions of two proposd cams, be assigned, we can readily find, by drawing such a curve, the limit of the eccentricity of the ellipses from which they can be made.

And so long as this limit is not transcended, we may also assign either the highest or the lowest value of the velocity ratio. When the point of contact is on the major axes of the ellipses, as in Figs. 17 and 18, the angular velocities are to each other in the inverse ratio of the segments into which the major axis is cut by the fixed focus. Suppose the value of this ratio to be given, as for instance $\frac{a}{b}$: then in Fig. 19, in order to find HP, we have, noting that HA=CP, and putting CP=x, the proportion:

$$x : AC + x :: b : a.$$
$$\therefore \quad x : AC :: b : a - b;$$

or,
$$x = AC\left(\frac{b}{a-b}\right),$$

whence the length of HP may be ascertained either by computation or by graphic construction; and this being done, the intersection E of the ellipse, whose eccentricity is thus determined, with the curve ABD, fixes the value of the other limit, which is the inverse ratio of the distances EC, EA.

But that other limit may be assigned instead of the first; in which case the solution may be effected by the aid of the construction illustrated in Fig. 20. Let it be required to draw a series of triangles having a common base LM, and the ratio of the other two sides equal to that of two given lines a, b. Divide LM at I, so that

$$MI : IL :: a : b;$$

also produce LM to K, making

$$MK : KL :: a : b;$$

then the locus of the vertices of the required triangles will be the circumference of the circle on IK as a diameter; thus

$$a : b :: MT : TL :: MS : SL :: MR : RL :: MN : NL.$$

If then in Fig. 19 the ratio of EC to EA had been assigned, AC would have been the base of the triangle in the preceding construction, and the point E would have been determined by the intersection of the circle with the curve AGBD, as shown in dotted lines.

We perceive then that no matter which limit of the velocity ratio is assumed, we are obliged to use an elliptical arc, of which one extremity lies upon the major axis, which cuts the arc normally. In that immediate neighborhood, therefore, the introduction of teeth is indispensable, as stated in the preceding article; and this is equally true whether the sectors be made in the form of the elliptical curve itself, or derived from it by the process of expansion or contraction previously explained.

As an example of the application of these principles in effecting a definite purpose, we will take the problem of laying out the pitch curves of the irregular wheels for an *intermittent* planetary train, like that described in the Scientific American Supplement, No. 483.

In Fig. 21, C is the center about which the train-arm CD and the sun-wheels *a*, *f*, revolve. Let it be required that the driven wheel, F, shall remain at rest while the train-arm moves through the angle PCQ of 90°, the wheel A being fixed; then the wheel F must be a circular one, of which the radius PC may be assumed, and the arc PQ of the irregular wheel A must also be circular and of the same radius.

It was shown in the article referred to, that the object in view may be attained by making the wheel *f*, which is circular, half as large as F; this makes the other segment PD of the train arm equal to ½PC, which is also the radius of the semicircular portion PSO of the irregular sun-wheel *a*. Draw DK perpendicular to the diameter PO, and RCG bisecting the angle PCQ; it is then seen that the problem reduces to the construction of two curves PK and PG, equal in length and capable of moving in rolling contact about D and C as fixed centers. The angles PCG, PDK, being respectively 135° and 90°, are to each other as 3 : 2, and the ratio of PC to PD is that of 2 to 1.

Now, referring to Fig. 19, the curve AID there shown is the one adapted to this particular case, the angles formed with HD, by lines drawn to C and A respectively, from any point of the curve, having the ratio of 3 to 2, and the dotted circle being so determined by the process of Fig. 20 that the lines drawn to any point of its circumference from C and A respectively shall be to each other as 2 to 1. This circumference cuts the curve in E, and EC+EA=HP, the major axis of the ellipse having the proportions required for our present purpose; and the elliptical arc EP is now to be contracted around the focus A until it subtends an angle of 90°, and around the focus C until it subtends an angle of 135°. We have thus two curves, of which the *forms* are correct; the first corresponding to PK, the second to PG, in Fig. 21. But as in the construction of Fig 19 the distance AC must be assumed arbitrarily, it probably will not happen that HP, thus determined, will prove to be exactly of the same length as the given distance CD of Fig. 21; so that it will in general be necessary to reduce either the original

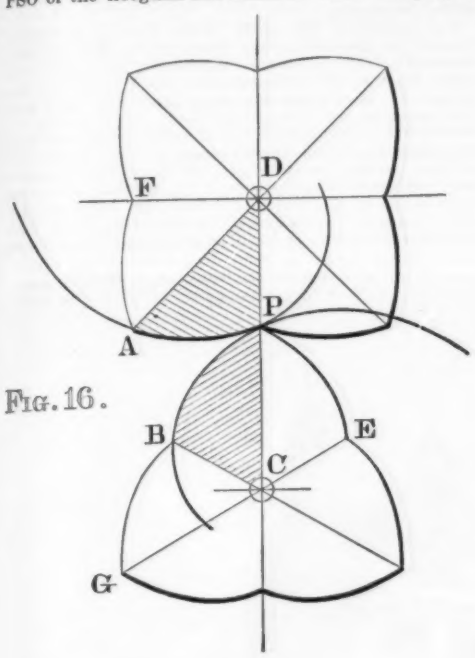


FIG. 16.

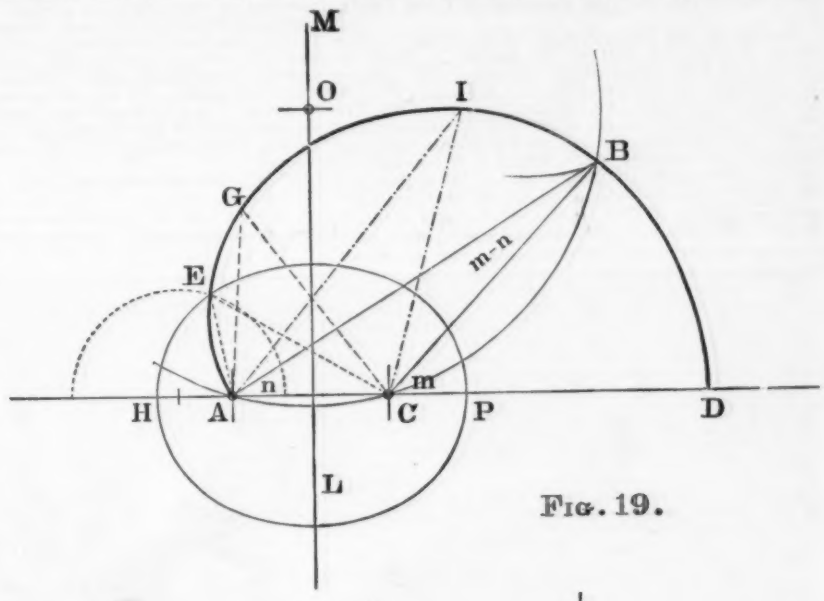


FIG. 19.

FIG. 17.

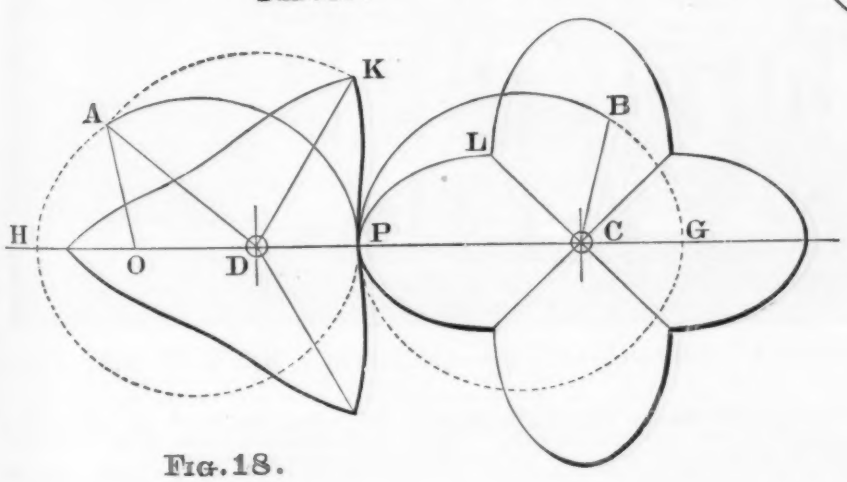


FIG. 18.

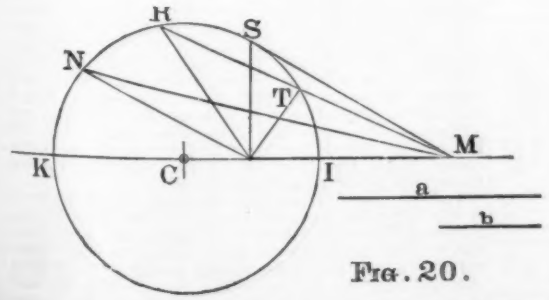


FIG. 20.

FIG. 21.

FIG. 22.

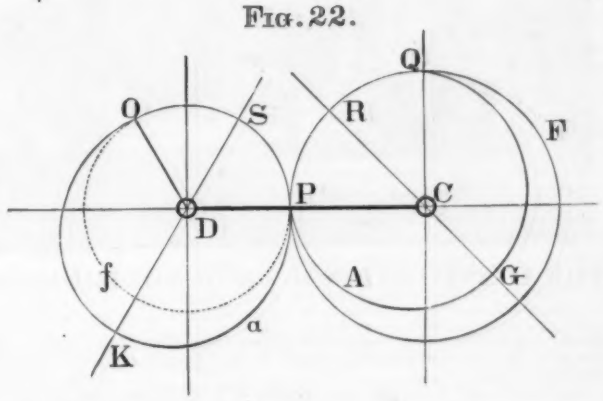
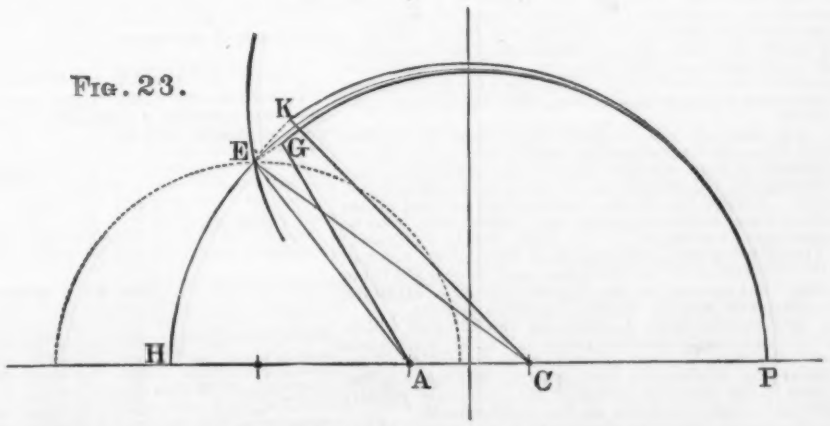


FIG. 23.



THE CONSTRUCTION OF ROLLING CAMS.

ellipse, or the curves derived from it, to such a scale as to make these dimensions the same.

The only condition assigned in regard to the action of this train was that relating to the duration of the period of rest. But there are two other elements not yet mentioned, viz., the maximum velocity of the driven wheel while it is in motion, and the magnitude of the angle through which it shall turn during a revolution of the train-arm. And without altering the first stipulation, these two elements may be varied to some extent, by changing the relative diameters of the circular wheels. The duration of the period of rest depends upon the angle subtended by the circular portion of the fixed wheel A, which in Fig. 22 is 90° as before, but in this case the diameters of F and *f* are as 4 to 3.

One-fourth the circumference of the larger is then equal to one-third that of the smaller, so that the circular arc PSO of the wheel *a* measures 120°. Bisecting this angle by the line SDK, and the angle PCQ by the line RG as before, we find that the curves PK, PG, are now to subtend angles of 120° and 135° respectively; which have the ratio of 8 to 9. In Fig. 23 are shown that portion of the auxiliary curve which it is necessary to draw in order to fix the proportions of the ellipse, and the process of contracting the arc EP about the foci into the working curves. This ellipse, it will be noted, is very different from the one shown in Fig. 19; and the action of the new combination differs from that of the first in every particular except in the length of the time of rest.

In Fig. 21, CG is to DK very nearly as 11 to 37, the maximum velocity of F is $\frac{11}{37}$ that of the train-arm, one revolution of which turns F half way round; while in Fig. 22, CG : DK :: 2 : 3, F makes one-fourth of a turn per revolution of the train-arm, and its maximum velocity is one-half that of the latter; the driven wheel revolving in the same direction with the arm in both cases.

But again, it may be worth while to point out that the four wheels composing such a train may be arranged in four different ways, each combination producing, for one revolution of the arm, a different result. Taking Fig. 21 for example, the sun and planet wheels may exchange places, and, considering *a* to be stationary instead of A, the effect will be as follows: The driven wheel *f* will remain at rest during one-half the revolution of the train-arm, and during the other half will turn once in the opposite direction, attaining a maximum angular velocity $5\frac{a}{f}$ times as great.

Or F may be fixed, A becoming the follower, which, starting from the position given in Fig. 21, will remain at rest during the first quarter of the revolution of the train-arm, during the next quarter will make a half turn in the opposite direction, its maximum velocity being $\frac{11}{4}$ that of the arm, and so on alternately.

If, finally, *f* be made stationary, *a* will remain at rest during a half revolution of the train-arm, which must then revolve once and a half in order to carry *a* one turn in the same direction, the maximum velocity being again $\frac{11}{4}$ that of the arm.

There are many other curves which are capable of working in rolling contact about fixed axes, and therefore of being used either as frictionless cams or as the pitch lines of non-circular wheels. Our object, however, is not to discuss methods of determining such curves in general, but to facilitate the practical operations of laying them out for specific purposes. And many if not most of those curves above alluded to are of a complicated nature, not well adapted to graphic processes, it being necessary in the majority of cases to calculate the values of the radiants by the aid of a mathematical formula. Now, given the total angular motions of two pieces in contact, and the limits of variation in the velocity ratio, it is clear that a change in the forms of the two rolling curves can affect only the *law* of variation between those limits, and that not to a very great extent. It is of course supposable that this precise law should be of prime importance; but such a case is seldom met with, and usually the requirements of the mechanism can be satisfied by a proper proportioning of the other elements just named.

If under these circumstances this proportioning can be effected, the curves determined, and the whole movement laid out by graphic processes without resorting to calculation, that fact will prove acceptable to many. We have therefore aimed at enlarging the scope of those processes, so that by simple manipulations with the familiar ellipse, we can solve in a practical as well as rigidly demonstrable manner, mechanical problems which we believe had not hitherto yielded to that mode of treatment.

COMPARISON OF GREAT GUNS.

The following table, taken from the *Armeeblatt*, gives an interesting comparison between the largest guns at present existent:

Type of Gun.	Caliber.	Length of Gun.	Weight.			Initial Velocity.	Total Energy at the Muzzle per Kilogramme of the Weight of Gun.
			Gun.	Shot.	Charge.		
	Min.	Met.	Kilogrammes.			Met.	
Krupp 35-cal., 30·5 cm...	305	10·70	48,550	455	141	530	0·104
" 35·5 " ...	355	12·40	81,350	725	225	530	0·103
German 30·5 cm., mar....	305	6·70	35,000	325	72	488	0·103
Russian 12 in. (long)....	305	9·14	43,341	344	138	507	0·140
French pat., 1870, 32 cm..	320	6·70	39,000	341	86	470	0·104
English, 80 ton m. l	406	8·15	82,900	771	294	498	0·114
" 63 ton b. l.	343	10·97	64,000	567	285	694	0·175
Italian 100 ton b. l.....	432	11·89	108,100	908	309	558	0·118
French pat., 1875, 34 cm..	340	6·70	48,340	420	117	480	0·101
Bange 34 cm.	340	11·80	87,500	450	180	600	0 221

THE CONSTITUTIONAL CLUB, NORTHUMBERLAND AVENUE.

This new club house, now in course of erection, next to the Grand Hotel in Northumberland Avenue, will be a very striking and handsome addition to the buildings in the street. The style of the new building is a free rendering of early Renaissance, with high pitched roofs and boldly shaped gables breaking up the sky-line. The front toward Northumberland Avenue, which is is over 200 feet in length, is finished with a boldly treated circular end to suit the requirements of the site; it will be entirely faced with red and buff terra-cotta, with elaborately modeled figures and enriched ornament.

The architect, Mr. R. W. Edis, F.S.A., of Fitzroy Square, has adapted a free treatment of domestic Renaissance to get over the difficulty of the large and small fenestration necessary for the different rooms; the general club rooms requiring large and lofty window openings, while the upper floors, which are entirely devoted to bed rooms for the club members, have openings of a much smaller scale, to suit the various rooms. On the ground floor will be a handsome and lofty entrance hall, off which there will be a reception room 36 feet by 27 feet. From the outer hall there will be a wide corridor leading to the octagonal inner hall, 30 feet in diameter. From this inner hall the principal

THE CONSTITUTIONAL CLUB. NORTHUMBERLAND AV CHARING CROSS ARCHITECT, MR R. W. EDIS F.S.A.

rooms on the ground floor will be approached; and a double marble staircase, 10 feet wide, will lead up to the principal rooms on the first floor.

On the ground floor there will be a reading room, 130 feet long by 30 feet wide, having the central portion recessed with circular bays at each end, giving a break of 50 feet by 27 feet in the center of the room. There will be a smoking room, 45 feet by 26 feet, on the ground floor, with the grand staircase and the necessary offices and service rooms.

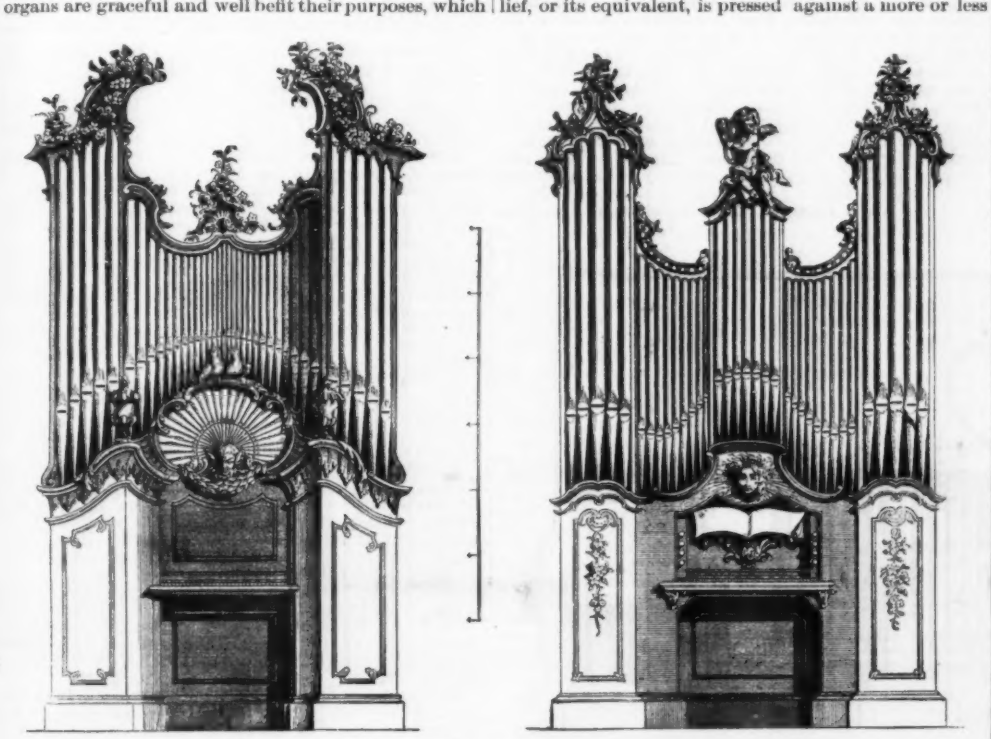
On the first floor, in the main building, will be a large general coffee room, 140 feet long by 30 feet wide, with the central portion recessed, similarly to the reading room on the ground floor, and finished at the narrow end with a circular open loggia, facing the river. There will be a large billiard room and library, and various offices, on the first floor. The second floor is devoted to committee rooms, house dining rooms, and billiard and card rooms. The three upper floors will be entirely devoted to club bed rooms; the servants' rooms being provided for in the various mezzanine floors facing Northumberland Street.

The building will generally be fire-proof throughout; it will be fitted up with every modern convenience, including hydraulic lifts to all parts, and a large elevator to all floors for the use of members. The general offices, including kitchen and rooms for the boilers, engines, and the dynamos for electric lighting and steam power, will be in the basement, and mezzanine over them. All parts of the building will be well lighted and heated, and thoroughly ventilated.

The site, which is a prominent and valuable one, being somewhat awkward in shape, required considerable skill in the arrangement of the various rooms, owing to the extreme depth at the end next the Grand Hotel, and to the narrow, wedge-shape form at the south end, dividing Northumberland Avenue and Northumberland Street. But the architect has managed to make the most of the site, by grouping his principal rooms round the octagonal central hall, and placing his main entrance at the wider end. With the sanction of the Metropolitan Board of Works terra-cotta has been freely used throughout, being considered by the architect the most suitable material for a London building, and especially adapted for the style chosen for the new club. The works are rapidly pushed forward by the contractor, Mr. Boyce, under the direct supervision of the architect, Mr. Edis; and it is expected that the club will be open for the use of members next year.—*Illustrated London News.*

TWO CHAMBER ORGANS BY CHIPPENDALE.

FROM time to time we have given interesting examples of church and chamber organ building, and in this way have published drawings of some really unique specimens. To-day we give two dated designs (1760), by Thomas Chippendale, the great cabinet-maker in England during the last century. The detail of the carvings to the upper parts is not, of course, such as the student now would copy; but this in execution was considerably toned down and modified by the actual carver, who gave an exquisite finish to his work, which is also full of spirit. The general outlines of the organs are graceful and well befit their purposes, which



TWO CHAMBER ORGANS BY CHIPPENDALE.

is frequently more than can be said for the regulation "Gothic" organ case, with its harlequinade pipes and gaudily decorated reeds.—*The Building News.*

HOW TO PREVENT CURLING IN UNMOUNTED PHOTO PRINTS.

ORDINARY single albumenized paper does not curl up in such a totally unmanageable manner as does the very high surface double albumenized paper now frequently used, but still it is very troublesome. The prints, if they are allowed to curl up, may be flattened in one of two ways The first and most popular is by laying them face downward on a pad of blotting paper or some similar material, and passing a hot iron carefully over the back. With small prints this treatment is usually quite satisfactory. With large prints, unless the amateur have the skill of a fairly expert laundress, he is certain to cause folds and wrinkles in the paper which can never be eradicated. Moreover, he is liable by the slightest overheating of the iron to turn the whites of the pictures into yellow.

The second method is that of passing a blunt paper-cutter over the back of the print while it is laid face downward on a soft pad. This method has the objection that it is almost certain to crack the albumen film to a greater or lesser degree.

By far the best way of treating prints which are not intended to be mounted is, in our opinion, to so dry and treat them that they are never permitted to roll up. There are various ways of doing this. If prints be allowed to drain for a few minutes, and then be laid between sheets of blotting-paper—or, still better, between drying boards, which are simply very thick sheets of blotting-paper with a smooth surface—if the sheets be piled one on the top of the other with a weight over all, and if the whole arrangement be allowed to stand for a few days, the prints will at the end of that time be found to be dry, and will have but little inclination to curl up.

A method which we prefer is the following: The prints are removed one by one from the washing water, each being allowed to drain till water ceases to drip from it. It is now blotted off with white blotting-paper, which ought to be that which is made specially for photographic purposes, and which is guaranteed to be free from hyposulphite of soda.

The print, when it is blotted surface dry, is laid face downward on clean blotting paper. The albumenized surface being downward, the weight of the paper restrains the inclination that there is for the edges to curl inward, and the prints may be allowed to get very nearly dry without curling into a condition at all unmanageable. When they are very nearly quite dry—which is indicated by their beginning to curl stiffly inward at the edges in spite of their lying face downward—they are piled one on the top of the other, no blotting paper or anything else intervening between them. A weight is laid on the top of the pile, and it is left for several hours or any longer time. If the prints be on single albumenized paper, they will without further treatment have been sufficiently flattened. Double albumenized paper is, however, very obstinate, and requires something more than merely lying flat under a weight.

A thin wooden roller is taken—one about an inch in diameter is suitable; on to this, one of the prints is rolled, albumenized side outward; the end of the print is caused to overlap the beginning of a second one by half an inch or so, and then the latter is rolled up till it overlaps and catches a third, and so on By this means a far tighter roll of prints can be made than by rolling them as they lie one on the top of another. The prints are allowed to remain rolled up for a day or more, when, if once laid out flat, they will remain so.—*Photo. News.*

SOME EASY WAYS OF MAKING GRAIN PLATES OR SURFACES FOR PHOTO-MECHANICAL PRINTING PROCESSES.

FIRST of all should be mentioned the method initiated by Fred E. Ives, in which an inked Woodbury relief, or its equivalent, is pressed against a more or less yielding surface, which is worked up into a series of projections, pimples, or grains, something like bookbinder's cloth, the face of a cross-cut file, or the surface of a nutmeg grater. Either the relief or the grain surface is inked with a printer's ink, or a transfer ink, and when the uninked surface and the inked surface are pressed together, the projections are crushed down, more or less, according to the height of the relief, and the result is an ink picture in stipple on the surface originally uninked, this picture being formed of dots, graduating from minute touches, where the relief is lowest, to solid blacks, formed by the running together of the dots where the relief is highest. Nothing need here be said as to the various means of transferring the grained image to stone for lithographic printing, or to zinc for etching into typographic form.

Next in order come the various processes in which a grain photograph is obtained by impressing a grain over the picture, whether by superimposing a grain negative and the photographing both together, or by successively exposing a plate to the grain negative and the photograph, or by lithographing a grain over a positive print. Methods of the above character are very numerous, and it would seem as if every possible variation had been suggested.

There are also methods in which a photo-lithographic paper, prepared in one of the usual methods, is grained by pressure against a rough surface, this graining being best done after the paper has been sensitized and dried; when such mechanically grained paper is exposed under a negative, inked, and developed in the usual way, it is found that the image often breaks up into a grain well suited for lithography or zinc etching.

The above notes having served to indicate the kind of way in which grained surfaces may be used for breaking up the half-tones of the photographic image into a stipple, we pass on without further preface to a consideration of means of making grained surfaces or plates.

In a recent number of the *Photographisches Archiv*, F. W. Geldmacher describes a simple method of making a random grain of any required fineness, with emery. A piece of six-sheet cardboard is uniformly brushed over with clear hot glue, and while the glue is still soft, emery of the required degree of fineness is sifted over it. When the card is quite dry, the loose emery is shaken off, and the rough surface is sized with a weak solution of glue, to which a small proportion of chrome alum has been added. When this is dry, the emery card may be freely handled, and used as indicated below. We have found the following to answer well as the final sizing preparation:

Coignet's gold medal gelatine.....	1 part.
Water	12 parts.
Bichromate of potassium.....	½ part.

The gelatine should be dissolved in the water at a moderate heat, after which the bichromate is stirred in, and the liquid is strained through fine muslin. Next allow the liquid to cool to nearly the gelatinizing point, and rapidly draw the sheet of emery card through the liquid, after which hang the card up to dry. It is much better to use bichromate of potassium than to employ chrome alum, as the former does not make the gelatine solution viscous, and it penetrates and insolublizes the under layer of the glue. In order to facilitate the action of bichromate, one would naturally hang the emery sheet in a light place to dry.

Let us now indicate some of the numerous ways in which the emery card may be used as a means of making grain surfaces. If one lays over it a piece of ordinary lithographic transfer paper, and passes both together through the press, a grained paper will be obtained suitable for certain forms of the Ives process, such as those in which the relief is inked; and the grain on the paper will be different, according to whether the prepared face, or the back, was placed next to the emery surface. In a similar way tinfoil may be grained and used as a medium in the Ives method; while the emery card may also be employed as a means of graining an ordinary sensitive photo-lithographic paper for the use already indicated.

If a grained block of soft metal be required, it is easy to obtain it by pressing or rolling a plate of the metal against the emery card; or if, on the other hand, a grained surface of hard metal is wanted—let us suppose steel—all that is necessary is to coat the steel with an etching ground, and then to press it against the emery card, using the hydraulic press or the rolling press; after which the plate is etched with a solution of perchloride of iron, this mordant acting through the fissures made in the etching ground by the grains of emery.

In case of a grain being required on a lithographic stone, or in the form of a typographic block, it is easy to ink the emery card, and to take an impression on lithographic stone or on zinc; the former being used for direct printing, or the latter for etching into relief by the chemigraphic method.

All the above may be performed, but in a far less satisfactory way, with commercial emery paper or cloth, as by taking ordinary care it is easy to turn out something far more uniform and satisfactory than the best emery paper of commerce.

In the above process it is sometimes advantageous to use find sand instead of emery, and in this case closely packed round dots are obtained. It is, however, very important to obtain sand free from dust, and of an approximately uniform degree of fineness; this being insured by screening out all that will pass through a sieve one degree finer than that first used.

It is a very rare thing to find a commercial sample of fine wire gauze sufficiently uniform to be used in the origination of a grain for printing, as the divisions are generally unequal, and oftentimes there are considerable intervals through which the wires are more or less closely packed than the average, this giving a lined and stringy appearance to prints grained by wire gauze. Wire gauze may be used in the same way as the emery card.

There are several comparatively coarse materials occurring in commerce which are tolerably uniform, and which, when reduced by the camera, make excellently grained negatives; among these may be mentioned some samples of coarse wire gauze, the fine perforated zinc which is used for meat safes, and certain woven materials, as the net used for women's veils, and a material sold in the draper's shops as *leno*. Any one of these may be stretched on a frame, and a reduced copy made in the camera, and from the negative first obtained a positive may be made by contact printing. Between negative and positive the most important difference is generally the relative proportion of the opaque to the transparent parts. It is scarcely necessary to point out when it is required to grain a plate which has already been exposed to the pictorial original; consideration of convenience must determine whether to make a second exposure in the camera on the coarse stretched fabric or perforated zinc referred to, or to use a reproduction and adopt the contact printing method.—*Photo. News.*

WOOLENS AND WORSTEDS.

AN interrogator asks: Are the preparatory processes for worsted the same as for woolens? To which we answer: Most decidedly not; while woolen stuffs are made from short-stapled wools, the manufacturer of worsted good is anxious to procure the longest and finest staple he can get in the market, and the various processes of manufacture differ in several important particulars. In the production of woolen goods, both the long and the short fibers are spun together without paying any attention to their relative positions, whether parallel or criss-cross; while in the manufacture of worsted, one of the most important operations is the combing for separating the short fibers from the long, by which these latter are layered parallel. Another point of difference between worsted and ordinary woolen fabric consists in that the latter, particularly broadcloth, has a fine nap on the face, and often on the back also, raised by passing the cloth over a cylinder armed with teasels, and afterward sheared, to give it an even surface. This nap is the natural accompaniment of a cloth made of short fibers, but does not to any marked degree exist in worsteds, which are woven of fine, closely twisted threads. Let us take the various processes which wool undergoes in its transformation into worsted goods, as pursued in the routine of a large Massachusetts mill:

The wool, after being sorted and scoured, is opened in the picker, which machine beats up and separates the fibers. It is then passed through the cards, and next passes to the combing machines, the essential feature of which is a pair of circular combs rotating in opposite directions, which separates the long and short fibers at the same time, laying the long fibers parallel. The long or worsted fibers are drawn off between rollers, and are called a "sliver;" the short uncombed wool which remains is known as "noils." Sometimes the

silver is passed through another combing machine, and subjected to the action of finer teeth. The following processes are drawing, roving, spinning, and twisting.—*Industrial Record.*

OZOKERIT.

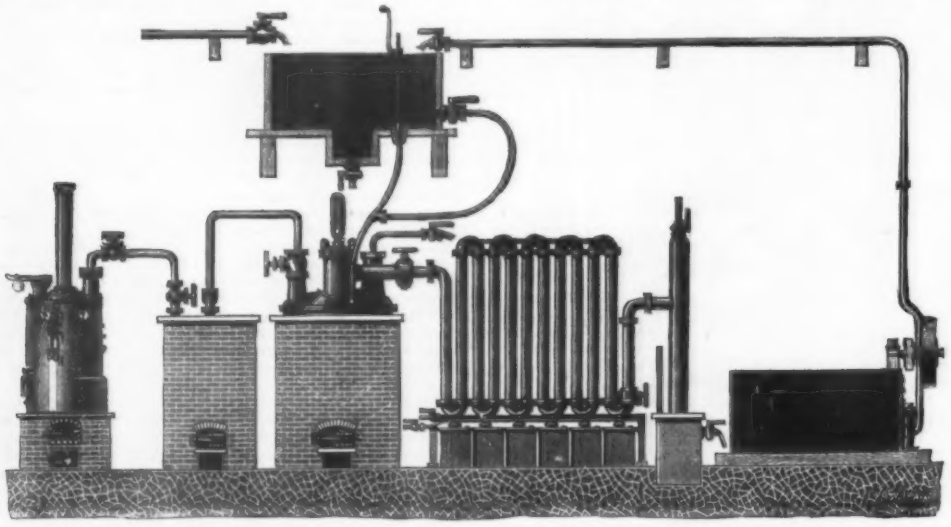
Ozokerit, the best electrical insulator known, is a fossil paraffine, sometimes called earth-wax. It is not abundantly distributed, for its production is confined to a few localities, chiefly in Moldavia and Galicia, where in surface mines it is dug up in nodules of about the size of potatoes. According to Gmelin, the ozokerit from Slanik in Moldavia is leek-green or yellowish-brown, translucent, flexible, and of the consistence of tallow or wax. Its specific gravity is 0·955 to 0·97; its melting point, 82 deg. Cent.; its boiling point, 210 deg. Cent.; and on distillation it yields gaseous, oily, and solid hydrocarbons, leaving 5·7 per cent. of carbon in the retort. It is slightly soluble in boiling absolute alcohol; it dissolves completely in bisulphide of carbon, rock oil, and oil of turpentine; it forms a jelly under benzol, and does not dissolve completely until it is warmed. Ozokerit from Zietriska, in Moldavia, melts at 84 deg. Cent., boils at 300 deg. Cent., specific gravity 0·946 at 20·5 deg. Cent. It is not attacked by alkalies, it softens in chlorine, and becomes soluble in boiling ether; it is not affected by cold sulphuric acid, but is carbonized by it when hot. The ozokerit from Trascowiec in Galicia melts at 59 deg. Cent. to 65 deg. Cent. Ozokerit from Boryslaw, in Galicia, is dark brown, and can be kneaded by the fingers; its melting point is 60 deg. Cent.; its specific gravity, 0·944. Its solution in boiling alcohol deposits, on cooling, crystals of the three forms in which paraffine crystallizes. By fractional crystallization it yields products melting at 60 deg. Cent. to 65 deg. Cent. of the same composition as paraffine. That melting at 61 deg. Cent. contains 84·94 per cent. of carbon, and 14·87 per cent. of hydrogen; that melting at 65·5 deg. Cent., 85·78 per cent. carbon, and 14·29 hydrogen. This ozokerit, when melted at a high temperature, is altered, and becomes softer than the natural substance. The solid product obtained by the dry distillation of melted ozokerit crystallizes from boiling alcohol in laminæ, which differ from wood tar paraffine in their high melting point, which is 62 deg. Cent. Ozokerit from Obora dissolves in nitric acid of specific gravity 1·34, after boiling for several days. Herman states that Neftgil, or Nefte dagil, is identical with ozokerit; it is a body which is brittle at 10 deg. Cent., and of the hardness of wax at 15 deg. Cent., obtained by the Tartars of the island of Tschelekan by burning a thick earth oil. Its specific gravity is 0·956; its melting point, 81 deg. Cent.; at a high temperature it distills almost without evaporation; boiling ether softens it, but dissolves very little. By dry distillation it yields oils and a buttery distillate, from which Hermann's "keron" may be obtained. This resembles, but is distinct from, paraffine, has a specific gravity of 0·893, melts at 67 deg. Cent., and on cooling solidifies to a crystalline brittle mass. According to Wohler, the meteoric stone of Kaba and that of the Cape contain an easily fusible carbonaceous substance resembling ozokerit.

According to Gmelin, the ozokerit from Urpeth coal mine, near Newcastle, is soft, unctuous, and sticky; it melts at 60 deg. Cent., and is limpid at 70 deg. Cent.; it contains 85·18 per cent. carbon and 14·06 hydrogen; it is a mixture of three substances of the same composition, all equally indifferent to boiling acids. The residue not taken up by boiling ether or alcohol, and amounting to one-sixth of the whole, is dark brown, soft, of specific gravity 0·965, melts at 73 deg. Cent., and boils at 260 deg. Cent. This residue is not absolutely insoluble in boiling alcohol and ether.

The ozokerit supply and distribution are in a few hands. The Austrian mines are in the possession of a few capitalists, and the purification, distillation, and distribution of ozokerit in Great Britain rest with the firm of Messrs. J. C. and J. Field, whose stearic acid works at Lambeth were described in these pages last Christmas. Mr. Leopold Field states that Galicia is the only district from which good crude ozokerit can be obtained, and that, too, from only one mine in the district, Boryslaw. His firm has received samples of assorted ozokerit from every quarter of the globe, but they nearly all proved to be either bitumens or sand infiltrated with petroleum. True crude ozokerit gives from 80 to 90 per cent. of solid paraffine; the rest of it consists of oil and dirt.

Messrs. Field's ozokerit works are at Battersea, on the southern bank of the Thames, up which river the ozokerit is brought from the Hamburg steamers in barges. The ozokerit arrives in blocks of chocolate color and somewhat sugar-loaf shape; each block measures about 2 ft. by 1 ft., and weighs from ¾ to 1 cwt. These blocks are made at Boryslaw by casting the crude lumps into tanks, and melting or steaming them down; the stones and foreign matters, which would increase cost of freight, sink to the bottom, and are thus separated in greater part. Crystals of rock salt, which are never far from an ozokerit mine, frequently project from the crude nodules, which also sometimes contain striæ of gypsum infiltrated with a small proportion of tarry matter. The ozokerit is usually nearly pure, and the inorganic materials traverse the substance in regular layers. When the cast blocks arrive at Messrs. Field's wharf alongside the works, they are taken out of the barges and stocked until required for refining or distillation; and it may here be mentioned that there are two ways of obtaining commercial products from crude ozokerit. The one method is to treat the material with Nordhausen sulphuric acid, and heating it until the acid is decomposed or evaporated, and has charred or decomposed the more destructible foreign matters present; the wax is then partly decolorized until it has a golden hue, and becomes what is known as ceresin, a substance largely used on the Continent for the adulteration of beeswax. Ceresin can, if necessary, be made almost a pure white; it resists the action of powerful chemical agents better than the true beeswax; it is not of much use for candle making, because of its unconquerable tendency to smoke.

At Battersea the ozokerit is distilled, which hitherto has always been necessary in preparing it for the making of candles, although Ujhely has devised a process by which the crude substance is dissolved in benzine or some other spirit, then filtered through charcoal to decolorize it, after which the solvent is distilled off for future use. At Messrs. Field's works the blocks, to the extent of about 5 tons at a time, are put into an iron tank about 9 ft. square, and subjected to the action of superheated steam, so that any remaining dirt of a coarse nature sinks to the bottom. The melted ozokerit is then pumped into a tank above the still, but when it is extra dirty is first treated with a little water and sulphuric acid. In this clarifying process the temperature employed is 190 deg. Fah. There are three iron retorts, each of about 4 tons capacity, with a furnace below, and a steam pipe down the interior of the retort; the steam keeps the mass in agitation, and helps



APPARATUS FOR PURIFYING OZOKERIT.

to drive over the volatile products into the condenser; it also largely prevents what is technically termed "cracking," that is to say, the breaking up of the oil into lighter hydrocarbons. The residue in the retort at the close of the operations is the "black wax," or insulating ozokerit; it melts at a temperature of 180 deg. Fah., and would make capital candles, but the public would no more buy black candles than they would buy white coals, or drink bottled stout out of a teacup. Why should black candles excite such subjective psychical impressions?

The series of U-tube condensers are of the usual description. They contain about 100 ft. of iron tubing of 1 ft. internal diameter. In the act of distillation a little oil comes over first, which is useful for burning purposes, then comes the mineral paraffine, known at this stage of the process as "press cake." The distillates are drawn out from the lower bends of the condensing tubes into little tanks, and the press cake is drawn off from the tanks into flat tin trays, in which it solidifies into flat oily cakes, measuring 24 in. by 14 in. by 1 in., and is then ready for pressing. The hydraulic pressing is effected in canvas bags between iron plates; it amounts to half a ton to the inch at a temperature of 150 deg. Fah.; the iron plates are hollow for the entrance of steam to keep up the temperature. Oil is thus squeezed out, and it is of use for the lubrication of machinery. The four hydraulic presses at the works act each upon twenty-six cakes at a time; the twenty-six cakes weigh 2½ cwt. The time of pressing is variable, but averages about two hours. To facilitate the pressing operations a little naphtha or paraffine oil is first added to the press cake; it is found to help to bring the natural oil out.

After the pressing the ozokerit is remelted in vats at a temperature of 170 deg. Fah.; there are five of these vats. In the final process it is decolorized by boiling for several hours with fuller's earth. The material in the boiling tanks is kept in agitation, and dried by hot air being driven through it. When decolorized, the material is left in the tanks all night to settle and cool, then is removed as the pure white ozokerit of commerce, the melting point of which is 140 deg. Fah.; the melting point of some of the solid coal tar paraffines is as low as 115 deg. Fah., hence the ozokerit candle has much less tendency to bend in hot climates or in hot rooms. The light of an ozokerit candle being reckoned at 10, that of sperm for the same weight of material is 7·5, of wax 7, of stearic acid 7·25, and of tallow 3·5. Three boilers, working up to a pressure of 30 lb. to 35 lb. to the inch, furnish the steam used for heating purposes in the manufacture of distilled ozokerit at Battersea. Two 14 horse vertical engines furnish the motive power consumed. The air pump is of the double cylinder construction; each cylinder is 30 in. by 15 in. There are extensive appliances at the works for the extinction of fire, for the cracking of a retort full of boiling ozokerit would be no trifling matter.

The engraving accompanying this article is not to scale, but represents diagrammatically the apparatus for the distillation of ozokerit as just described. It will be noticed that two pipes from the upper tank communicate with the still; the second is used as a safeguard, supposing the other should be accidentally choked with dirt. At the end of the condensers is what is known as the essence tank; some of the lighter hydrocarbons will not condense, so a little jet of water plays up the inside of this tank, catches the lighter vapors, and brings them down with it.

In the course of the ozokerit manufacture a by-product is obtained resembling vaseline, though differing from it in chemical composition. This substance is in general though limited use for the dressing of leather, and as axle grease; it is also used to some extent in pharmacy. The black wax so well known in telegraphy for its insulating powers is further used by coopers to help in making barrels watertight, also by makers of tarpaulins and waterproof fabrics.—*The Engineer.*

THE CLARIFICATION AND PURIFICATION OF PUBLIC WATER SUPPLY.

By L. H. Gardner, Supt. Water Works, New Orleans.

It is an evident inference from the increasing literature upon the general subject of water supply, and the reports of water companies and departments, that a practical, efficient, and economical method of treating objectionable waters in order to render them potable, sightly, or otherwise acceptable, is a desideratum.

The difficulties encountered in the case of polluted streams, whose pollution is, to a large extent, beyond the prevention of existing laws, elimination of algæ, and the generation of spores in tanks or reservoirs, the deposit of finely divided clay or similar sediment, such as is carried in suspension in our Western waters; in fact, an effective system for the general modification or improvement of the character of a water supply, together, perhaps, with the treatment of sewage, seems to be somewhat of a standing interrogation point.

In this paper I do not propose an answer or a universal remedy, but rather to offer another interrogation point after the word *iron.*

In what I shall have to say on this subject, my desire is to draw more attention to an agency which may accomplish an invariably perfect result. If compared with other agencies in the matter of expense, let it be judged similarly in comparative results.

It may be assumed that in a very large number of our American communities the public water supply demands improvement before delivery to the consumer. The particular character of the desired improvement is not perhaps exactly alike in any two cases. If any one "cure-all" has been adopted in preference to others, that remedy has been, in one form or other, *filtration.* If filtration is demonstrably a success, if in any form it responds to requirements, further inquiry is unnecessary. If it is not, and if the system fails of its object, then its cost or efficient value cannot fairly be compared with a system which will answer fully to the demands put upon it.

Some sources of public water supply need improvement more than others. The gradation runs from a delicate criticism of the eye or palate up to the stern demands of sanitary considerations. The value of a clarifying or purifying system depends upon these varied circumstances.

In the case of private companies, it also depends somewhat upon the increase of revenue which may be anticipated from its adoption. I submit, then, what I have to say, rather as a suggestive statement than as an argument, for I have no present or prospective pecuniary interest in the subject.

It is now some three years or more since my attention was accidentally drawn to the favorable influence of iron upon water, and I had not pursued my investigations very far before ascertaining that its agency had been recognized and commented upon in a passing manner by veterans in the study of water supply. The only practical use in which I found such a system, however, was in some places in England and at Calcutta under the so-called "Magnetic Iron Process" of Mr. Thos. Spencer. About that time Antwerp was perfecting an application of iron in the purification of domestic supply.

There had been one other experiment, which is thus noted by Fanning:

"Dr. Gunning demonstrated by many experiments that the impure waters of the river Maas, near Rotterdam, could be fully clarified and rendered fit for the domestic supply of the city by the introduction of 0·032 gramme of perchloride of iron into one liter of the water. The waters of the Maas are very turbid, and contain large proportions of organic matter."

Before dismissing this allusion I would say that, as far as I can learn after diligent inquiry, Dr. Gunning's demonstration has not been followed up by any practical or extended application.

I have been at some pains to learn the practical success and acceptability of the water resulting from the Spencer process. As well as I am informed, it accomplishes what sand filtration cannot, in highly objectionable water, but is criticised as expensive, and further that the clarified water often contains an excess of iron. I have not been able to procure information as to the cost of the process. I made official inquiry through the Belgian Consul at New Orleans regarding the cost and success of the Anderson system at Antwerp. It delivers from two to two and a half million gallons daily, clarified by passage through a revolving drum or drums charged with iron filings or borings, and subsequently through sand filter beds to remove excess of iron.

The official answer to my inquiries, freely translated, is as follows:

"In answer to the interrogatories of Mr. Gardner: It is yet difficult to estimate the exact cost of using the Anderson purificators. Up to date it has been very

small. The motive power required to turn the apparatus is trifling. The cost of cleansing is really nothing, from the fact that the particles of iron are kept clean by reciprocal frictions. All oxidized matters are removed by the current of water and deposited on the sand filters. The quantity of iron used in the Anderson apparatus does not exceed one-tenth of a grain per gallon, or about 15 lb. per million gallons. The filings of cast iron that can be employed for the purification would cost perhaps 10s. per ton, making the cost of iron employed amount to about ¾d. per million gallons. The cost of cleansing the sand filters averages 12s. per million of filtered gallons, including the cost of the purified water employed to wash the sand. In our works at Waelhem we have established three Anderson purificators No. 10, which can together purify 2,200,000 gallons water per day. The value of these three machines is £1,350, and the cost of their installation, including the building in which they are located, was about £300. The water retains no traces of iron after being filtered through sand. The daily consumption of water at Antwerp at this time of the year (July) is about 2,000,000 gallons, and it is all subjected to this process of iron purification."

This account or report is signed by E. Devonshire, Engineer of the Antwerp Water Works, and approved by the city authorities.

I beg to call attention to the estimate of cost of filtration by this process, which, if even approximately correct, is wonderfully low. The waters of the Nethe, from which Antwerp draws its supply, are not only turbid, but highly contaminated with organic matter.

It will be observed that in both the Spencer and Anderson systems clarification is practically based upon contact with iron, the excess of the latter being supposed to be eliminated by subsequent sand filtration.

In turning to the system of filtering beds and filtering galleries, it is scarcely saying too much if it be remarked that none of them are to be found in commendably successful operation either in Europe or America.

Perhaps Poughkeepsie, N. Y., ought to be excepted. The investigation of one or two visiting friends and other inquiries encourage indorsement of Nicholls' comment in his recent work:

"The most valuable data of the expense of filtration, as drawn from actual experience, are found in the reports of the Poughkeepsie water works. From these data it seems the expense may be set at from $2.50 to $3.50 per million gallons, not allowing for the interest on the plant or for the cost of pumping. The original cost of the beds was $54,000 (29,000 sq. ft.), the interest on which would exceed the cost of maintenance."

Poughkeepsie is a city of 20,000 inhabitants. Its daily water consumption is 1,400,000 gallons. It is situated on the Hudson River, a sluggish stream seemingly without motion or current, and without appreciable sediment throughout the year. The motive for filtration at Poughkeepsie was evidently born of the idea of contamination from the sewage, etc., of other towns and cities along the banks of the Hudson, and the beds are not operated continuously, that is, the total yearly supply does not pass through them. There is wanting a comparative description of the water before and after filtration.

Some year ago, Boston caused estimates to be made of the cost of a filter bed system, resulting in the figure of $11 per million gallons, including interest on plant. This is said by well informed students of the subject to be a probably fair estimate for a water which does not carry a heavy sediment or any considerable amount of organic matter.

Several cities of the United States have filtering beds or filtering galleries; and while the literature on water supply alludes to them in respectful terms, the success of their systems in the desired direction does not appear to be commended by any writer in any respect or from any point of view. There is a singular and almost total absence of information as to the cost of maintenance and of the improvement of water effected by this agency.

The city of Toledo, Ohio, derives its domestic supply from the turbid Maumee River. T. J. Cook, C.E., of that city, after experimenting largely upon filter beds in connection with this public supply, and after a wide experience in the matter of filtration upon both the large and small scale, and after a study of the subject as exhaustive perhaps as has been given to it by any other, has expressed himself to the writer to the effect that filtration as a system is a failure.

T. F. Frankland recently reported to the Royal Society of England a series of experiments upon the purification of water. In his paper, speaking of filtration he said: "Thus green sand, coke, animal charcoal, and spongy iron were at first successful in removing all organisms from the water passing through them, but after one month's continuous action this power was in every case lost. The improvement still effected, however, by spongy iron and coke was very great indeed, while the green sand and brick dust were much less efficient, and the number of organisms in the water that had been filtered through charcoal was greater than in the unfiltered water." An eminent hydraulic engineer once said that filter beds fail only because they are overcrowded. Give, said he, one-half the earth for filter beds for the use and benefit of the other half, and we will have no trouble about a clear water supply.

The city of St. Louis is meditating, if not actually committed to, an effort in the line of extensive filter beds, at an estimated cost, it is said, of some three millions of dollars. The result will be looked for with impatient interest as a demonstration of the system under fresh auspices and adapted by the intelligent judgment of one who has studied Western waters independently and as a disciple of Kirkwood. I refer to Col. T. J. Whitman, water commissioner of St. Louis. If any one can command success from the system, he can, and will.

The waters of the Mississippi at New Orleans are always turbid, carrying in suspension, by my own experiments, from 75 to 200 grains of solid matter to the gallon. There is practically no organic matter of animal origin, and comparatively little of vegetable origin to deal with. A natural rest of 24 hours will effect a precipitation of 80 to 90 per cent. of the clayey sediment. There will then be left, not a clear or colorless water, but a water still containing a finely divided clay in suspension. This gives the water a milky hue not pleasant to the eye or to esthetic taste, or popular with the average consumer, or, except to a modified and limited extent, capable of accurate measurement for an extended period by a water meter. This last named objection is due to the insoluble silica which is the predominant constituent of the sediment of our Western rivers. Even in its finest state of division it cuts and wears machinery of all kinds, and the delicate mechanism of water meters makes them too short-lived for economical use in such water. Proud as we are of the Mississippi as a source of supply, and highly as we value its sediment, which seems to give it its self-cleansing and self-preserving qualities, we would be glad from that source to furnish our communities with a colorless water.

Looking to quick results and entire success in the object of purification to be attained in this or other sources of supply, I am persuaded that the use of iron in some form is the true agency. It is difficult for one to read the experiences and opinions of those whose mission it is to study the subject without concluding that filtration, on any scale, however extended, is but a system of straining, and that it has never fully answered to desired results—this, whether the desired object be the elimination of sediment or of algæ, of spores or of general organic impurities or defilement. Speaking for our Western waters, it may be confidently said that filtration on an extended scale accomplishes only what a twenty-four hour rest in a reservoir would effect. In 1883, Mr. I. S. Hyatt, of Newark, N. J., visited New Orleans with a filter, the principal and most valuable feature of which was a self-cleansing device. The courtesies, privileges, and facilities of the yards and works of the New Orleans Water Works Company were extended to him for some four months. During that time he experimented on an extended scale with every known filtering medium or material, and utterly failed in the filtration of Mississippi River water in such a manner as to deliver continuously a colorless water. Meantime I was experimenting with lime, alum, and the various salts of iron, with a view to reservoir clarification. These experiments were the subject of his pleasant ridicule. Toward the close of his stay in New Orleans, I prevailed upon him, in his disappointment, to try a precipitating agent or coagulant in the water previous to its introduction into his filter. He experimented in this direction, succeeded, and I believe obtained a patent upon the combination. Several of the Newark filters embodying this feature are in use in manufacturing establishments in and about New Orleans.

For a very large or public supply it seems scarcely necessary to say that if prompt and economical results can be secured in reservoirs or tanks by defensible chemical precipitation or clarification, filters are not needed. The chemical clarification of water is not a new proposition. It has been used, with various agencies, for centuries. The methods and agents have varied with the surrounding conditions, just as have the supposed adaptation of herbs and other natural remedial agents for the cure of disease.

Among the agents (other than iron) thus used may be mentioned lime, alum, borax, oxalate of potassa, and the now unknown vegetable processes of the ancients along the banks of the Nile and elsewhere. To these may be added the use, under special circumstances, of permanganate of potash.

After experimenting with all the known agents, I express my preference for iron. I am also convinced that a *solution* of iron is of easier mechanical application to water, and by its fluid adaptability is subject to such control as the character and treatment of the water may demand. This graduated application will in intelligent hands obviate the necessity for subsequent filtration. The only trouble would seem to lie in the direction of the cost of the solution.

The salts of iron have hitherto been made only upon a limited scale and for medicinal purposes. Their production in such a manner, or after such a formula, would of course be too expensive, if not prohibitory, for the purpose suggested.

If, however, red hematite iron ore be employed, and treated simply with hydrochloric acid, bringing it to say 50° B., or to say 1·50 specific gravity, the solution suggested can be made in large quantities at a very low cost.

With such a solution I conducted a series of experiments of a minor and preliminary character. I verified them in the reservoirs of the New Orleans Water Works. The water thus clarified was analyzed with entirely favorable results by Prof. Chandler, of New York, and by Professors R. N. Girling and Joseph Jones, of New Orleans.

Later I verified the result upon the largest scale permissible in the United States, viz., in the settling basins at St. Louis. In August, 1884, by the courtesy of Col. T. J. Whitman, C.E., water commissioner of St. Louis, and aided by Mr. Wm. Golding, M.E. of New Orleans, I clarified a body of 13,000,000 gallons. The result was in every way prompt and satisfactory. The solution used in the demonstration, the water in various stages of precipitation, and the colorless resultant water were all subjected to chemical analysis, and with unqualifiedly favorable reports. The action is partly chemical and partly mechanical. In the water of the Mississippi there exist carbonates of lime and magnesia. Contact with the chlorine in the iron solution forms chloride of calcium, and coincident therewith is the formation of a hydrated oxide of iron. This latter settles rapidly, carrying with it all suspended matters, leaving the water clear. The use of a solution of 1·60 specific gravity in the proportion of one part in 20,000 clarifies the muddiest water, and neither hardens the water nor leaves any trace of the iron therein. A smaller amount may be used successfully.

The waters of the Mississippi River at New Orleans can be rendered crystal clear by the process described, with a rest of say eight hours in reservoir, at a maximum running cost of one cent per 1,000 gallons. The cost will be less if a longer period of rest be allowed. It will also be decreased if the clarifying material be manufactured by the water company or department. The cost of a plant for its manufacture will not be large.

I beg to suggest to any interested reader of this paper that he procure a small quantity of perchloride of iron, and experiment with it. This salt is superior to the sulphate for the purpose. The latter is cheaper to manufacture, but I am impressed with the belief that water clarified by its agency will not retain its integrity, and that its hardness is increased materially. Perchloride of iron, as now made and understood, is too expensive for large or extended use, but its action on water is identical with that of the solution heretofore alluded to. Alum will clarify some waters but not all, unless used in objectionable quantities, such as will, it is said, affect health injuriously. It perceptibly increases the hardness of the water, and in leaving sulphates in solution is apt to render it objectionable for boiler or laundry use.

After many experiments, and on several waters, which I confess were to a large extent empirical, I am convinced that iron is the agent of all agents to which we must look for the cure of most, if not all, of the evils of which our communities now complain, in connection with their domestic water supply. If surroundings will permit its economical addition, let the quantity of iron be reduced and the feature of *aeration* be added, and perfect results could not be avoided in treating any water supply.

In reference to the removal of organic matter by this agency, Nicholls, in speaking of the Antwerp process says (Nicholls on Water Suppiy, p. 173): "Although . . . . it is difficult or impossible to obtain a water free from iron, there is no doubt that a considerable portion of the dissolved organic matter is removed, and it is claimed that the bacteria and bacterial germs are completely removed. These claims are borne out by the experimental investigations of Bischof, Hatton, and others, and give to the material a great theoretical advantage."

And in further allusion to Bischof, Fanning says in his work on Water Supply Engineering: "Dr. Bischof patented in England in 1871 a process of removing organic matter from water by using a filter of spongy iron prepared by heating hydrated oxide of iron with carbon. The water is said to be quite perceptibly impregnated with iron by this process, and a copious precipitate of the hydrated oxide of iron has afterward to be separated."

Mr. F. H. Williams was charged by the authorities of St. Louis with the analysis of the basin of water clarified in August, 1884, by the solution of iron process. In closing his report he says:

"A beneficial result is shown in a reduction of the organic matter, due to the action of the hydrate of iron, amounting in this case to thirty per cent. It can be said without hesitation that when used in the proportions experimented with, this use of iron cannot affect the water in any way detrimental to public health, nor in any way change its nature for the worse for any manufacturing or other purpose to which a city water supply is put. There is no reason to believe that any harmful effect could be possibly produced upon animal life in the water. The clarifying agent is introduced in such relatively minute quantities, and its action is so instantaneous, that the clarifying process has really begun in less time than one-half minute after its introduction, and it has already been demonstrated that the iron introduced is at once decomposed into harmless products."

For the use of iron as a clarifying and purifying agent, see also Muspratt's Chemistry, p. 1085, vol. ii.

I deem it a step in advance of all filtering processes in treating large quantities of water, and the rapidity of action narrows the necessary area or capacity of settling basins very materially. Mechanical devices of the simplest character will suggest themselves to any intelligent mechanical engineer when he is simply required to introduce into the inflowing water, while in motion, a current supply of one-fifth of a pound of a solution of iron to a thousand gallons of water.

Reservoirs can be made self-cleansing, or can be constructed with this view. J. D. Cook, of Toledo, Ohio, has patented such a reservoir feature. The cost of the process is the only possible objection, but if it secures a speedy and *perfect* result, perhaps this may be deemed a fair offset to the objection. A maximum estimate has been given, and the variation below that will, of course, depend upon the character of the water treated.

The Board of Directors of the New Orleans Water Works Co. has formally indorsed the process here suggested as being feasible, practical, and satisfactory, but there are good and sufficient reasons for their postponement of its practical adoption. In conclusion, I would say that this paper is not prompted by any selfish motive. It is designed for the consideration of water work officials whose public supply demands any kind of improvement. If it awakens any community to a consideration of the value of the process, or of any process of iron clarification, and if its adoption anywhere proves a success, its object will be attained.

MAGNETIC SEPARATION OF MINERALS AT OBERLAHNSTEIN.

By Mr. O. HEBERLE.

AT the Friedrichseger silver and lead mine at Oberlahnstein, where a large quantity of mixed blende and spathic iron ore is produced, the separation of the minerals has for the past three years been effected by an electro-magnetic process, which is applied alike to both dressed and hand-picked ore. The latter is mainly delivered in lumps varying from 40 to 120 millimeters in diameter, while the former ranges from 6 millimeters downward. The operations proper to the process are three in number, namely:

1. Roasting.
2. Separation by electro magnets.
3. Finishing concentration.

Roasting.—The object of this operation is to render the ore magnetic, by converting the ferrous carbonate into magnetic oxide. The larger lumps are roasted in kilns, being charged alternately with coke screenings in the usual way. Owing to the large amount of sulphur in the ore, the consumption of fuel is very small, being only 1 cwt. per 8 tons, the latter amount being daily put through the kiln, which is served by two men. The cost of kiln roasting is about 9½ d. per ton. The roasted ore is reduced by stone breakers and crushing rolls to particles of 5 millimeters maximum size, which are fed mechanically to the electro-magnetic machines. The fine-grained products from the dressing processes are calcined in long flat-bedded reverberatory furnaces, an operation which is complete in about one hour and a half. Two furnaces are in use, one with working doors on both sides, and a smaller one worked from one side only. Together they roast 18 to 20 tons in twenty-four hours. The cost both for

fuel and labor is much higher than in the kilns, and is computed at 2 s. 6 d. per ton.

Magnetic Separation.—The roasted ore is spread out on a floor to cool, and separated from sintered lumps, when it is lifted by an elevator, and passed through a sizing-drum to remove particles above 4 millimeters, which are returned to the crusher, while the finer siftings pass to the electro-magnetic machines. These differ materially from machines previously used for the same purpose, as they are continuous in action, while the magnets are kept out of contact with the material under treatment. The machine has a fixed horizontal axis, carrying a series of electro-magnets arranged radially on a frame, covering an arc of about 90° within a brass drum, nearly, but not quite, touching the magnets, which receives motion from a belt and pulley. The outer surface of the drum is made into an elevator by a series of small ribs projecting radially. The magnets, which are so arranged that the lower series is a little below the horizontal plane, face the feeding-apron, which, by an arrangement similar to that of a percussion table, delivers the ore from the feeding hopper in a thin stream against the excite-surface of the drum, when the magnetic particles are retained and travel upward, being kept from falling by the radial ribs, and passing over the vertical plane fall off on the opposite side, while the blende particles, not being attracted, fall down a shoot into a hutch in front. The separation is only approximate, and has to be repeated upon the roughly classified product of the first operation, the ultimate products being—

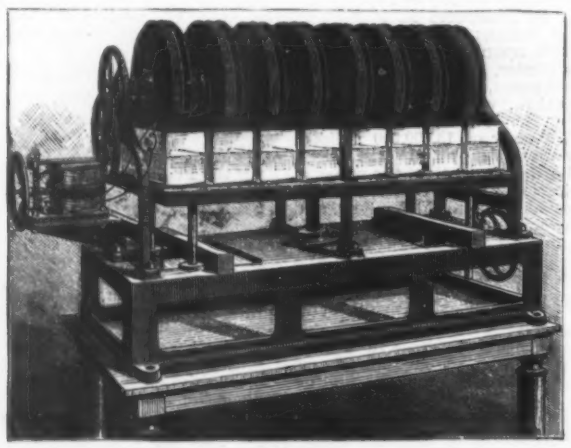
1. Blende and quartz.
2. Spathic ore.
3. Mixed blende ore.
4. Mixed iron ore.

The two latter classes requiring further treatment. As the operation is attended with the production of much dust, the whole of the apparatus is connected with an exhaust-fan working continuously. Sixteen machines are in use. They are arranged by series of four, of which an upper pair effect the first rough separation, and deliver to the finishing pair placed below them. The four machines in each series are excited by a Gramme dynamo of 1 horse-power; the current is introduced at one end of the hollow axis of the drum and passes out by the other. Each of the two divisions of the establishment (eight machines) treats 24 tons of roasted ore in twelve hours, producing 7 to 8 tons of blende and 16 to 18 tons of iron ore. The rough stuff from the mine averages 12 to 15 per cent. zinc and 20 to 22 per cent. iron, which gives dressed zinc ore of 33 per cent., and iron ore with 36 to 38 per cent. of iron and 10 per cent. of manganese.

Finishing Concentration.—The iron ore obtained as described is not subjected to further treatment, but the blende requires further concentration in jigging machines. For this purpose, the blende freed from iron ore is delivered by an elevator to a sizing-drum, which divides it into three sizes, of 3, 2, and 1 millimeter, each of which is treated on a separate jigging machine to remove earthy waste, as well as intermixed lead ore. This gives a final salable product enriched up to 38 per cent. of zinc and lead ore, with 65 per cent. of lead, and 40 grammes of silver. The fine stuff and dust from the exhauster are treated on slime buddles, and give a zinc product of 32 per cent., and lead ore of 65 per cent. —*Berg- und Hüttenmännische Zeitung.*

BAZIN'S ROTARY PILE.

The agitation of the elements of a pile and the renewal of their active surfaces constitute a mode of depolarization that is already very old, and from time to time new models appear in which the inventor endeavors to utilize such action to advantage. One of the most recent attempts in this line is the rotary pile lately presented by Mr. Bazin to the Société Internationale des Electriciens, and shown in the annexed engraving. Upon an axle fixed in space are mounted eight elements, each composed of a zinc placed between two carbons. Communication between these different elements is established by stripes of brass affixed to the axle. Seven of the elements are coupled for tension, and serve to supply the external circuit, while the eighth element, forming an insulated circuit, supplies a small electric motor that serves to communicate to the axle a rotary velocity of about one revolution per minute. The active liquid is contained in oblong glass



BAZIN'S ROTARY PILE.

troughs placed upon a horizontal table that may be moved up or down by means of a screw actuated by a hand wheel at the right of the apparatus.

Each trough contains 5¼ pints of a bichromate of potash solution of the following composition:

Water	1,000	parts by weight
Sulphuric acid	300	" " "
Bichro. potash	125	" " "

We have had an opportunity of making some experiments with this pile, and of studying its constancy with different discharges. It has not, in our opinion (up to the present, at least), answered the expectations of its inventor. The curves of discharge have always shown rapid decreases after but an hour's operation. It is possible, it is true, to lessen this decrease in the discharge by a suitable immersion of the elements and by an increase of surface to compensate for the increase in internal resistance; but frequent maneuvers like these are incompatible with the ordinary needs, of practice. In fact, we think that a more regular operation and a greater constancy would be secured with *immovable* elements, on condition that a proper surface were given the zincs and carbons. The benefit of rotation, then, is entirely lost in consequence of an arrangement that we consider as vicious. In fact, Mr. Bazin revolves both the carbons and the zincs. For the former this is undoubtedly an advantage, but for the latter it is manifestly the opposite, since these carry along with them a certain quantity of the liquid, and this attacks them out of the liquid without producing any electric energy, and thus uses them up prematurely. Under such circumstances the pile operates with as much local action as would a bichromate element whose zinc surface were uselessly exaggerated. We believe that Mr. Bazin is occupied in modifying his pile in the direction indicated, that is, in such a way as to render the zincs stationary—a circumstance, moreover, that will much facilitate their exchange. We shall await there new elements and new experiments in order to publish some figures, for those furnished by the present elements are far from being favorable, and in no wise justify the dithyrambic articles with which the political press has saluted the appearance of this pile and called the attention of the public to it.—*E. Hospitalier.*

A HIGH-PRESSURE INFLUENCE ELECTRIC MACHINE.

By Walther Hempel.

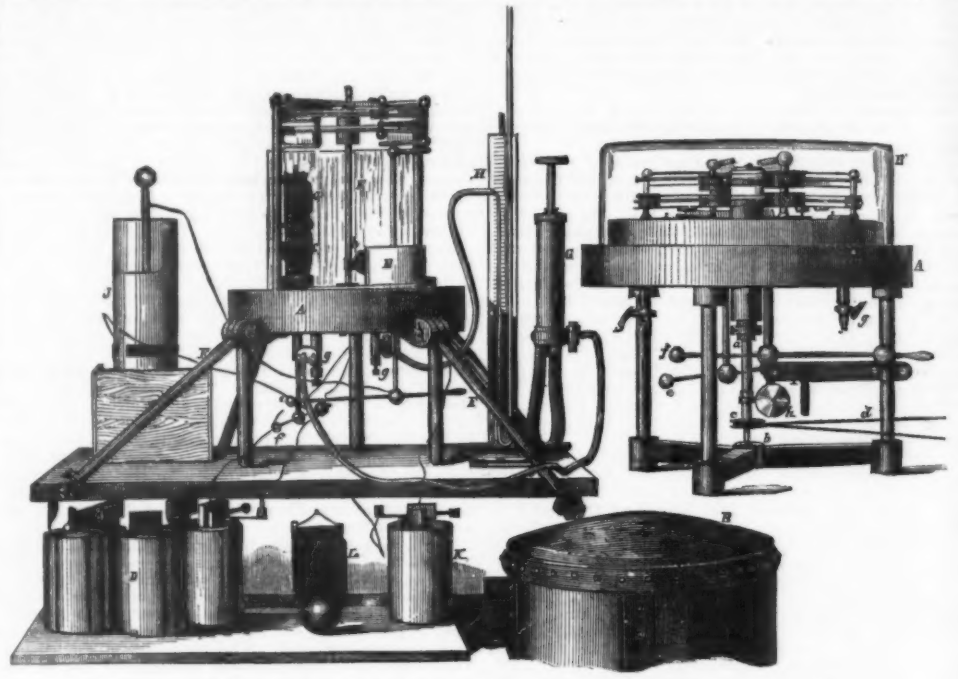
In January, 1884, I published in the *Berichte der Deutschen Chemischen Gesellschaft* a memoir on the effect which the chemical nature and the pressure of gases exert on the development of electricity by influence machines. I had then ascertained that the quantity of electricity produced by an influence machine depends both on the nature and the pressure of the ambient gas. The continuation of these researches has become important, since it appears that machines permitting the application of high pressures evolve considerably more electricity than those now in use.

Fig. 1 shows the arrangement of the machine as used in my first experiments. With reference to the arrangement of the disks, coatings, and absorbers, Topler's construction was selected, though the axle is placed vertically instead of horizontally. The axle passes air-tight through an iron plate, A, and rests at *a* in a stuffing-box and at *b* on a point. The motion is given by means of a small drum, *c*, and a belt, *d*. The polar balls of the machine, *e* and *f*, are fixed on supports movable in all directions, fixed in the iron plate and insulated by means of vulcanite disks.

On the extreme edge of the iron plate are cast two concentric ridges, forming a deep groove, in which the glass bell, B, can be placed. The iron plate is further fitted with two cocks, *g*, and a rotation indicator, *h*, for the purpose of comparative measurements.

All the space beneath the glass bell not taken up by the glass-work of the machine is filled up, as far as possible, with paraffine. If a little mercury is introduced into the groove of the plate, the machine is enclosed perfectly air-tight, and yet it can be opened without difficulty.

If oil of vitriol is also placed under the bell, the machine is soon surrounded by air absolutely dry and



HIGH PRESSURE INFLUENCE ELECTRIC MACHINE.

free from dust, which offers the great advantage that it always excites itself at once, and can be used even in the worst atmosphere of a laboratory.

It was found that the glasses of machines thus fitted up do not require to be lacquered, so that all parts of the machine are perfectly proof against the action of the ozone which the machine generates when working in air. We can also, without interfering with the action of the machine, use ordinary window glass (which for the common construction is quite useless) for the preparation of the disks, as it insulates quite sufficiently in perfectly dry air.

As the paper coatings of the machine when perfectly dry cease to conduct electricity, they must first be rubbed over with graphite, which renders them slightly conductive.

The arrangement just described permits of the use of various gases, but it excludes the use of high pressures. Fig. 2 shows the arrangement adopted for studying the action of the machine at different pressures.

To render measurements possible without the disturbing effect of friction in a stuffing-box, the machine was placed on the iron plate, A, under an iron bell, B (represented in the figure as lifted off), in such a manner that the movement is effected by a small dynamo machine set in motion from without by the battery, D. It was thus possible to keep the friction of the pegs constant at varying pressures, and to effect a really perfect closure of the space under the bell. The entire room under the bell not required for the moving parts of the bell was filled up with paraffine, E. The iron bell was lined internally with a stratum of paraffine an inch in thickness, and could be pressed down upon a caoutchouc ring laid upon the plate, A, by means of four iron screws, F. The plate contained two valves, *g*, one of which is in connection with a forcing pump, G, and the other with a pressure gauge, H.

The conductors to the polar balls, *e*, *f*, were carried through the plate insulated by means of long glass tubes. For measurement, a Leyden jar, J, was used, standing in a box filled with melted paraffine. The Leyden jar was connected by wires with the supporters of the polar balls.

Besides, there was in the machine a revolution indicator, *h*, connected by wires with an element, K, and an electric bell, L, and so arranged that on the completion of every 100 rotations a contact took place and the bell sounded.

The connection between the dynamo and the influence machine was effected by drums and driving belts. To render it possible for the dynamo to be started in any position by simply closing the circuit, it was constructed as a twin machine, so that two small dynamos were united in one. Their keepers were fixed on one and the same axle, and were so placed with reference to each other that the one machine was in the maximum of its action when the other was at the dead point. The arrangement described enables the influence machine under the bell to be set in motion at pleasure in different gases and under varying pressures, the revolutions of the glass disks to be counted and the quantity of electricity evolved to be measured.

EXPERIMENTS WITH THE INFLUENCE MACHINE (FIG. 1).

The quantity of electricity was found by counting the number of discharges given by a Leyden jar for the same number of revolutions and at the same mutual distance of the polar balls.

The machine had lacquered disks. It appeared that on using hydrogen gas the collector points of the machine were not luminous in the dark, while in all other gases this took place very distinctly.

1. The machine gave with hydrogen at 850 rotations per minute 9 discharges, while in air with the same number of rotations there were 45 discharges.

2. In carbonic acid for 850 rotations there were in the mean 47 discharges, a part of the carbonic acid being at the same time converted into carbonic oxide and ozone.

3. The machine, further, when running at the rate of 400 rotations per minute in air at the normal pressure, gave 15 discharges per minute and 32 on an increased pressure of the atmosphere. On diminishing the pressure by half an atmosphere below the normal pressure, the Leyden jar could not be charged at all.

An attempt to obtain larger quantities of electricity by causing the machine to run under petroleum (which is a notable electric non-conductor) proved unsuccessful. It is possible that by using sliding springs instead of the recipient points of the influence machine, a result might have been obtained. It is possible that the petroleum insulates so well that the points are unable to transfer the electricity.

Experiments show that the chemical nature of gases exerts on the one hand an influence on the development of electricity by the influence machine, while on the other there ensues with increasing pressure an enormous increase in the quantities of electricity produced.

For utilizing the electricity produced by influence machines an arrangement like that in Fig. 1 is suitable, but with the difference that instead of a glass bell an iron cap is used, which may be fixed down air tight with strong screws.

The above researches have been made with a Leyden jar—a rough measuring instrument—in order to obtain an insight into the total phenomena. The pure electric determinations of the dielectric constants of the gases at high pressures must be reserved for future investigations.

Oskar Leuner, mechanician to the Dresden Polytechnicum, has made the entire apparatus in a most satisfactory manner.—*Annalen der Physik und Chemie.*

CLOG ALMANACS.

BEFORE the invention of printing, considerable difficulty was experienced in remembering the different saints' days and other holy days, and various expedients were made use of to assist the memory, the most usual of which was a perpetual calendar, engraved on some hard substance, either on a large scale or a small one, according to circumstances. At the present day, when every cottage is supplied with its penny almanac for the year, to be thrown aside as waste paper at the year's end, if not previously worn out, it is not easy

Clog Almanack. Bodleian Library, Oxford. | *Clog Almanack Ashmolean Museum, Oxford*

to realize the very opposite state of things which existed in the middle ages; but the very difference makes it a matter of interesting research to find out the means employed by our ancestors as a substitute for our almanacs. We occasionally find a perpetual almanac engraved on a large scale on the wall of a church; one of these, as early as the twelfth century, still exists on the wall of the church of the city of Perigueux, in the south of France, and a few others of later date have been preserved. The emblems of the different seasons, with the characteristics and the usual employment of each, are also frequently used as ornaments round the arch of a doorway, and in other situations; and they abound in illuminations of manuscripts. Perpetual almanacs were also engraved on metal, on bone, on ivory, and on wood of different kinds. The most common are on boxwood; these are usually cut on square logs, and are often called Danish almanacs, or Runic calendars, being supposed to be of Danish origin, although they were extensively used in England. These vary considerably in size, some being small enough to carry about conveniently, others made to hang up by the side of the fireplace, a custom which continued in old-fashioned farmhouses within the memory of man, and which Dr. Plot, who wrote a history of Staffordshire and of Oxfordshire in the latter part of the seventeenth century, describes as common in his day. They have now become rare, and are met with only in museums or collections of curiosities; there are several in the Bodleian library and in the Ashmolean museum at Oxford; and two in the Cheetham library at Manchester.

Some of these are very rude, as if cut by a laboring man with his pocket knife. Some are on flat strips of wood; others, as we have said, on square sticks, from which they were also called "log almanacs," or "clog almanacs," clog being a provincial word of the same signification, commonly applied to the piece of wood which is tied to restive animals to prevent them running away or getting through edges.

There were two kinds of these almanacs; one for the immovable feasts, the other for the movable, with the Sundays also, and these are the most usual. When the almanac is on a square stick the days are marked by notches on the angles, the seventh day being distinguished by a deeper notch, and the festivals by their usual emblems, some of which are very curiously expressed. We give engravings of two, one from the Bodleian, the other from the Ashmolean; both of these are believed to be of English workmanship, but some of those in the Ashmolean are clearly Danish or Swedish, having Runic (or secret) characters upon them, and having been presented by a Swede, John Hensig, in 1681, who stated that they were then in use among the agricultural classes in his own country. The emblems or symbols employed seem to have been purely conventional, and nearly the same on all.

The strokes with dots on the right hand side of each face of the almanac denote the golden number or cycle of the moon; if the number is under five, it is represented by so many dots; if five, by a sloping line from the notch for the day, forming with the straight line a rude V, which stands for five. If the number is above five and under ten, it is marked by the number of dots on the sloping line added to five. When the number is ten, a cross stroke makes a rude X, which stands for ten, and the figures above ten are again marked by dots. These clog almanacs were also called prime-staves, because the prime or golden number was marked upon them. This will be more clearly understood by referring to the calendar at the beginning of the Prayer-book, particularly the table to find Easter, and the direction for using it, where the golden number or prime is mentioned.

Annexed will be found, besides the reduced sketches of the "clogs," some of the emblems selected and drawn to the full size of the originals.

We at once recognize the keys, which were through-

ST. PETER.

out the middle ages considered as the emblem of St. Peter.

The next to it is not at first sight so plain. It occurs, however, on the day on which St. Lawrence is commemorated, and therefore without doubt is intended for the gridiron; this martyr having been broiled to

ST. LAWRENCE.

death because he refused to give up the treasure of the church which was be supposed to be in his custody.

St. David's day is marked by a harp. It was not intended by this to confuse the Welsh Archbishop with the holy king, but the similarity of the name was a

ST. DAVID.

sufficient ground for the use of the well-known emblem of the minstrel.

St. John the Baptist's day is distinguished by the figure of a sword, the instrument of his death.

ST. JOHN THE BAPTIST.

In the same manner we find the hatchet as the em-

ST. PAUL.

blem of St. Paul, as tradition informs us that he was beheaded.

It is useless to remark upon the appropriate emblem of the Epiphany, namely, the star.

EPIPHANY.

But the next, even when we know that it occurs on St. Swithin's day, is very puzzling. It has been explained as intended to represent a shower of rain.

ST. SWITHIN.

The last is the emblem of St. Michael. The office of weighing the souls of the good and bad against each other has been always, in mediæval lore, assigned to

ST. MICHAEL.

this saint; hence the scales are employed in the clog almanac as his symbol.—*Printer and Stationer.*

PHASES OF AMERICAN PROGRESS.

THE address of Mr. Atkinson, as Vice-President of Section 1 of the American Association for the Advancement of Science, at the recent meeting at Ann Arbor, recognizes the great progress made in material welfare during the past twenty years, both in the production and the distribution of wealth. But he urges that we have no right to rest upon past achievements. During the past twenty years improvements have been mainly devoted to the increasing production and the cheaper distribution of food. With free commerce over a larger area and among a greater number of people than enjoy the same freedom in any other part of the world, it has come to pass, he claims:

1. That nowhere else are the products of labor and of capital so ample.

2. Nowhere else are wages and profits so high.

3. Nowhere else is the cost of production measured in labor so low.

4. Nowhere else are high wages so sure to be the result and reward of a low cost of labor.

5. Nowhere else is so much general benefit derived from the expenditure of money raised by taxation.

6. Nowhere else is so small a part of the public income used for destructive purposes.

Mr. Atkinson refers especially to the increase in railway mileage, which is partly a result of the Bessemer mode of making steel, and to the extraordinary progress made in securing cheaper transportation. The general use of the screw propeller has resulted in an enormous saving, and likewise the use of agricultural machinery, the opening of oil wells, the invention of aniline colors, the employment of electricity, the development of machine tools, and many other improvements to which he calls attention. Comparative safety from loss by fire has been attained by better construction of buildings. Attention is called to the progress already made in the use of phosphate deposits, and to the opportunity for almost unlimited increase in the use of such deposits at the West, and salt deposits of Canada. In spite of all this, Mr. Atkinson maintains that the average product of the people does not exceed 50 to 55 cents per day for each person. The progress of invention or machinery has displaced a great number of workers for a time. On the other hand, the reaction from a period of unusual activity in railroad building has displaced, he maintains, more than 100,000 persons formerly engaged in such labor. There is enough in the country for all, and yet there is little room for further saving in some directions—in the cost of transportation, for example—while in other directions there is still enormous waste, and especially in the distribution of perishable commodities.

Mr. Atkinson urges that the waste land of New England can probably be employed most profitably by use of the phosphates without nitrogenous fertilizers, and instances his own experience, stating that he has himself supported two cows every year from the product of one acre for five years past. He presents a body of interesting information regarding the use of cotton seed, and the cost of raising cattle with pitted corn as a chief element of food, and believes that New England can yet raise animal food at a less cost than it can be produced in Texas, and can grow all the beef it can eat from its waste land, if the methods he discusses prove feasible.

Concerning the value of different articles of food in consumption, Mr. Atkinson presents tables prepared in part by Professor Atwater and by German scientists, showing the proportions of protein, of fats, and of carbo-hydrogens in the different kinds of food in common use. In the same connection tables are given of the kinds of food most largely employed in this and in other countries, and it is interesting to observe how the natural tastes of the people in many countries have led them to prefer articles of diet which contain, in large measure or at the least cost, the chemical elements necessary to sustain life and to maintain strength for productive labor. The information on this subject which the address presents is too scientific in character for popular

appreciation, but it is interesting to know that the Scotchman who prefers his oatmeal, and the New Englander who prefers his pork and beans, and the Southern negro who chooses above all things hog and hominy, all have a scientific reason for preferring, as the cheapest in proportion to the nutrition contained, the very kinds of food of which they seem most fond.

REMEMBER THE SKIN.

THERE'S a skin without, and a skin within,
A covering skin and a lining skin;
But the skin within is the skin without,
Doubled inward and carried completely throughout.

The palate, the nostrils, the windpipe and throat,
Are all of them lined with this inner coat,
Which through every part is made to extend,
Lung, liver, and bowels, from end to end.

The outside skin is marvelous plan
For exuding the dregs of the flesh of man,
While the inner extracts from the food and the air
What is needed the waste of the flesh to repair.

Too much brandy, whisky, or gin
Is apt to disorder the skin within;
While if dirty and dry, the skin without
Refuses to let the sweat come out.

Good people all, have a care of your skin,
Both that without and that within;
To the first give plenty of water and soap,
To the last, little else but water, we hope.

But always be very particular where
You get your water, your food, and your air;
For if these be tainted or rendered impure,
It will have its effect on the blood, be sure.

The food which will ever for you be the best,
Is that you like most, and can soonest digest;
All unripe fruit and decaying flesh
Beware of, and fish that is not very fresh.

Your water, transparent and pure as you think it,
Had better be filtered and boiled e'er you drink it,
Unless you know surely that nothing unsound
Can have got to it over or under the ground.

But of all things the most I would have you beware
Of breathing the poison of once breathed air;
When in bed, whether out or at home you may be,
Always open the windows and let it go free.

With clothing and exercise keep yourselves warm,
And change your clothes quickly if caught in a storm;
For a cold caught by chilling the outside skin
Flies at once to the delicate lining within.

All you who thus kindly take care of your skin,
And attend to its wants without and within,
Need never of cholera feel any fears,
And your skin may last you a hundred years.
—*N. Y. Herald.*

ERYSIPELAS.—ITS RAPID CURE.

WHILE several American surgeons have mentioned lead paint in these cases, the credit of bringing it prominently before the profession is due to Mr. Richard Barwell, of Charing Cross Hospital, who, in the *Lancet* of March 10, 1883, described what he termed "A Rapidly Successful Treatment of Erysipelas," which consisted in painting the parts thoroughly with white lead paint, dressing the wound, if there be any, by cotton wool saturated with boro-glyceride. The effect was remarkably and quickly successful; cases after operations on the arm for necrosis, and other hospital cases, being well in a few days. The pain was relieved almost at once, and only such after-application needed as to keep the coating perfect. In idiopathic erysipelas, he found it equally successful.

Since the publication of Mr. Barwell's cases, I have used no other local application for erysipelas, and have often used no internal treatment except the purge as he recommends.

Pure white lead paint of the shops is likely to dry too slowly, and I tell the painter to add some drier, as in ordinary painting, which in no way changes the effect of the application.

I am unable to give the composition of this drier, as it is a patent preparation; but painters tell me it is some kind of resin dissolved in linseed oil.

The paint should be thicker than for ordinary use. It peels off readily when desquamation begins, even from the head, where I have often applied it.

The mention of cases in detail seems unnecessary, but several instances of especial interest have been noted. A man whose right ear was completely involved was relieved at once of the burning pain, and recovered without a second application. The same rapid results have been obtained in my practice when the disease involved the nose, face, and various other parts of the body.

Being hastily summoned to a patient who was attacked with facial erysipelas, I found that the disease began thirty-six hours previously, and had rapidly spread over the entire face. The temperature was 103°, in the axilla, and the pain was severe. The husband was a painter, and had the white lead paint and drier in the house. It was thoroughly applied over the face, and they were requested to report the condition of the patient on the following day. They failed to do so, and months afterward, when visiting a patient in the same family, I learned that the single application cured the disease.

Mr. Barwell reports similar rapid results in traumatic cases, and even in hospital cases.

While the application of this remedy gives the patient a somewhat striking appearance at times, when a single ear or the nose is affected, for example, yet it is a dry and cleanly dressing, very easily applied, and as successful as can be desired. It is beyond all question preferable to any means which have been in use up to the present time, and is still entitled to its designation as a rapidly successful treatment of erysipelas.—*Dr. Daniel Lewis, Jour. C. and V. Diseases.*

NUTRITIVE VALUE OF THE DIFFERENT PARTS OF THE GRAIN OF WHEAT.

M. AIME GIRARD has recently contributed an interesting article on this subject to the *Annales de Chimie et de Physique*. He treats the grain of wheat as consisting essentially of three parts: (1) The integument, including not only the pericarp, but also the outer envelopes of the endosperm or albumen; (2) the embryo, separated from the endosperm; and (3) the mealy endosperm, freed from its outer envelopes. He discusses these three constituents in detail, from the points of view of their anatomical and chemical composition, the part taken by each in the composition of bread, and their properties in relation to digestion; the general result being that the endosperm is the only part of the grain which is of value for nutritive purposes without a compensating drawback, the integuments and embryo being either useless or actually injurious.

The integument, which makes up 14·36 per cent. of the entire grain, is rich in nitrogenous substances, to the extent of 18·75 per cent., but these substances are only to a very small extent soluble in the digestive apparatus of man; the portion that is thus assimilable being only 0·4 per cent. of the whole grain. Among these nitrogenous substances is the cerealin discovered by Mege-Mouries, the ferment which causes the formation of black bread. In addition, there are mineral substances which are soluble in the gastric juice to the extent of 0·45 per cent. of the grain.

The embryo contains a still larger proportion of nitrogenous substances than the integument, and especially of such as are apparently assimilable. But it also is of scarcely any service for nutrition, because of the large proportion which it contains of the injurious cerealin, in addition to a very easily oxidizable oil, which easily escapes from the cells in which it is formed, distributes itself through the flour, and assists in its decomposition. The maximum amount in the embryo and integument together serviceable for nutrition is 1·0 per cent. of nitrogenous and 0·5 per cent. of mineral substances. And even of those nitrogenous substances which are soluble in water, the greater part appears to be of very small nutritive value.

This small addition to the nutritive value of the grain of wheat is greatly outweighed by the disadvantage of the increased facility for the quick decomposition of the flour given by the presence of these substances, and the increased tendency to the production of an oily, heavy bread. It would appear, however, that substances which are not adapted for digestion by the human stomach can be assimilated by the digestive apparatus of other animals.

The object, therefore, to which millers should especially direct their attention, is the discovery of mechanical means by which the integument and the embryo may be removed from the grain, reserving the mealy endosperm alone for the production of flour.—*Pharm. Jour. and Transactions.*

WHOOPING COUGH.

Ammoniac	1½ to 7½ grains.
Syrup of orange-flowers or of red poppy.....	375 "
Infusion of elecampane or of Virginia snakeroot.....	1,125 "

Dose, a teaspoonful, to be repeated with greater or lesser frequency, according to the child's age and the effect produced. When the expectoration is very abundant and as if formed of muco-pus, a terebinthinate (sirup of fir-cones, of eucalyptus, or of turpentine) is prescribed. Flowers of sulphur, mixed with honey (from three-quarters of a grain to two grains or more of sulphur), may also be given twice a day. It is well, too, to rub the chest or the sides of the neck with a soothing ointment, such as one containing a drachm of the extract of aconite or of conium to half an ounce of lard.—*N. Y. Med. Jour.*

ACETIC ACID FROM WOOD.

IT is well known that most of the acetic acid sold in the United States is produced by the distillation of wood, but some details of the operation may be new to our readers.

Among other volatile products of this distillation are marsh gas, olefiant gas, and liquid at ordinary temperature, benzole, toluol, phenol, etc. This distillation is usually carried on in iron ovens or retorts, into which the wood is introduced.

In some cases the more volatile matters, such as water mechanically absorbed or contained as sap, are driven off by the application of a lower degree of heat, and in others this is not considered necessary. In some factories wood is treated both for its volatile products, such as acetic acid, benzole, and creosote, and for charcoal. In these the charge is ignited with free access of air until carbonized, which is predicated when the smoke given off becomes bluish instead of dark and heavy. The air supply is then shut off, and in place of a clean combustion the decomposition desired by the manufacturer is effected. The yield of acetic acid, as well as of liquid products, with the exception of benzole, in general, is less when the wood is rapidly charred. In operating upon refuse wood, such as sawdust, spent dyestuff and tan bark, retorts of special form are necessary, as the application of heat is almost immediately followed by the formation of an exterior coating of hard carbon, which effectually protects the interior of the mass from the action of heat. This fact prevented, for a time, the utilization of such materials, but the difficulty was overcome by exposing only thin layers of material to the heating surface. The retort for this operation consists of a horizontal cylinder of iron, containing for its entire length a screw, which, while moving the materials steadily on by its revolutions, keeps it evenly distributed over the bottom of the retort. The cylindrical retort is so built as to expose the greater part of its length to the heat of a furnace, while at one end is a provision for feeding the material regularly. The other extremity has two branches; one running directly downward terminates in a tank of water, into which the carbonized substance falls; the other leads to the condenser. Where wood is operated in billets, simply cast or wrought iron ovens capable usually of holding about one-half a cord are used, and the vapors conducted to a suitable condenser. The amount of acid and charcoal obtainable from a given weight of wood varies with the kind of wood employed, but in general may be stated as something under fifty per cent. of charcoal. This acid is the crude product containing tarry and other empyreumatic products, known in commerce as pyroligneous acid. It is purified by subjecting to a slight heat, to separate benzole, and saturating the acetic acid with lime or soda. The salt is calcined in order to decompose the tarry matter present, and afterward distilled with a sulphuric or hydrochloric acid, which combines with the base and sets acetic acid free. This part of the manufacture is not always carried on by the distiller of wood, who must, from the nature of his crude material, operate near the source of his supply. Therefore, the acetate of lime is a commercial article from which the manufacturing chemist may produce the acid in question. One advantage of this is that the solid acetate is more cheaply transported than the liquid acid.—*Chemical Review.*

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